TEXT BOOK

OF

ELEMENTARY ANATOMY, PHYSIOLOGY

AND

HYGIENE

BY

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LAHORE

UTTAR CHAND KAPUR & SONS

FOREWORD

· have read "Elementary Anatomy, Physiology and Hygiene" by Capt. L. P. Mathur with interest. Capt. Mathur has taken great pains in collecting the various details accurately. He has planned the chapters in proper manner, ·aking the book a comprehensive and practical ·le for the students. He has put the facts in imple and lucid way and the students for ·om it is meant are sure to find it useful and nstructive. I am sure that it will find its proper place in the libraries of High Schools and Intermediate Colleges.

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PREFACE.

At the request of Messrs. Uttar Chand Kapur & Sons, Publishers, Lahore, I undertook to write an elementary text-book of Anatomy, Physiology and Hygiene. This book is designed for use as a text-book for the syllabus in the subject in the Board of High School and Intermediate Education, Ajmer.

One of the most important things is to take the best care we can of our health. This is not only essential for our own sake, but for the sake of others as well. We never realise fully how good a thing health is until we are ill.

In the first part of the book, we will discuss the wonderful nature of the human body—its structure and functions.

In the second part, we will discuss the various means and ways of keeping people in perfect health of body and mind. We must know how to make our surroundings healthy.

The question that all right-minded persons have to ask sooner or later is what they will do with their lives. It is surprising, apart from very serious diseases, how many comparatively smaller defects can bring down the general efficiency of an individual.

Few people have an idea what an efficient body is and how it works. Although it is a very complicated machine, yet it should be possible for every one to have a clear idea of the body's general structure and the way in which its more important parts function. Given good bodies, there is no reason why we should spoil things by having physical troubles that are due to unwise habits.

L. P. MATHUR,

July 1940 *St. John's College, Agra.*

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PART I

ANATOMY AND PHYSIOLOGY

CHAPTER I

Introduction. The human body is an animal organism, differing in only a few respects from other animal organisms, and fitted for the performance of two main functions :

(*i*) The conversion of food and air into energy, and into tissue.

(*ii*) The reproduction of other individuals of its kind.

The living body. When we look around us we see a large number of things—living and non-living. In the living group, we should place all the plants and animals including human beings ; and in the non-living, bricks, stones, earth, sun, moon, watches, chairs and a number of other things. What is the difference between the living and the non-living ? The following are the chief characteristics of the living things.

(*a*) movement,
(*b*) power of growth,
(*c*) power of making heat, and
(*d*) power of reproduction.

The science which deals with living things is called Biology.

The human body is a wonderful machine and yet very often it is carelessly treated, for its possessor does not care to find out how to make the best use of all its powers. Give the body a sporting chance to live well and you will find the world a wonderful place to live in. The science which deals with these matters (preservation of health and prevention of disease) is called Hygiene. But the first necessity for healthful living is some knowledge of the structure and functions of the human body. The science which deals with the make-up of the body is called Anatomy, and the science which deals with the ways of action (functions) of the body is known as Physiology.

The human body is made of a vast number of units called cells, each with its own special work to do. A cell is a small particle of semi-fluid living substance called protoplasm, the outer surface of which may sometimes become

firm enough to form a cell wall. The cell nearly always contains a prominent structure, the Nucleus.

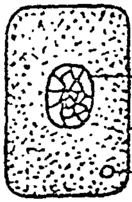


Fig. 1.—A typical cell.

Sometimes the cells act singly as in the case of the white blood corpuscles ; but more often a number of cells of the same kind are collected together into Tissues (such as muscular tissue). There are five general kinds of tissue :

(1) Epithelial-tissue—this is represented by the skin, by the lining of the inside of the mouth, the coat of the intestines and stomach, etc.

(2) Connective-tissue—this is represented by bone, cartilage, etc They are the binding or cementing elements in the body.

(3) Blood.

(4) Muscle-tissue—this consists of three types of cells ;

(*a*) the voluntary muscle cells (banded or striated), such as the muscles of the arm which we can move at will ;

(*b*) the involuntary muscle cells (unstriatc , uch as are found in the intestines and con act without the owner's will.

(*c*) the Heart muscle cells—they resemble in appearance the voluntary muscles, but like the involuntary muscles contract without the owner's will.

(5) Nervous tissue—this is made up of specialised cells ; they consist of a cell-body from which goes out a long thread to make contact either (*a*) with a muscle, or (*b*) with taste buds on the tongue, organ of hearing, etc. ; or (*c*) with other nerve cells.

Tissues carrying out the same kind of work are collected into Organs, such as the heart, kidneys, lungs, etc.

In certain cases two or more organs combine to serve some special function, and such a combination is described as a System, as for example, the digestive system.

The General Arrangement of the Body. Let us now consider very briefly the general build of the human body as a whole. The skeleton and the attached muscles give the body s characteristic shape, and support the whole structure. The muscles covered with the skin and its appendages give the familiar appearance to the human body.

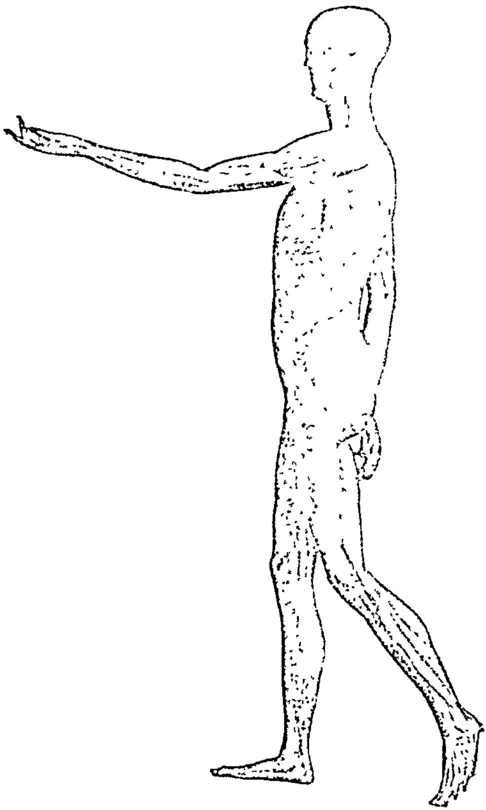


Fig. —The Muscular System.

The body is divided into head, trunk and limbs.

(*i*) *The Head* consists of two parts : (*a*) the skull enclosing the brain, and (*b*) the face.

(*ii*) *The Trunk* : It contains a large cavity which is divided into two compartments by means of a muscular partition known as the Diaphragm. The upper compartment is the thorax or chest, and the lower one is abdomen. Inside the thorax, are lodged the heart, lungs, the food pipe, and the wind pipe These are protected on all sides by the vertebral column, sternum, and the ribs. (See Fig. 4). The abdomen contains the stomach, small and large intestines, spleen, pancreas and the kidneys.

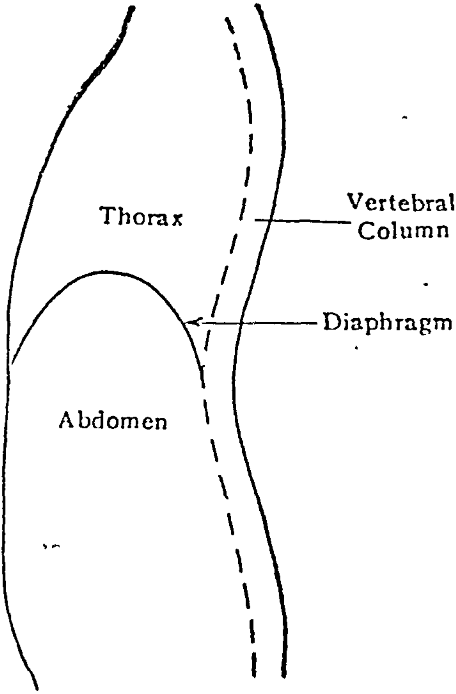


Fig. 3.—The Body Cavity.

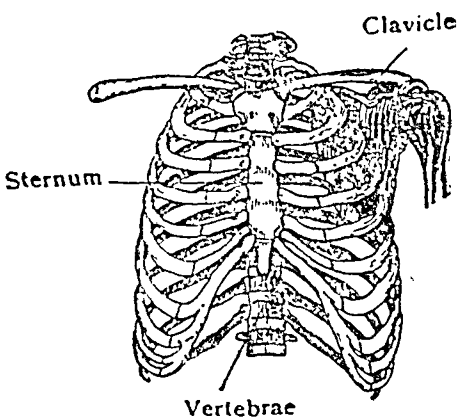


Fig. 4

The Chest

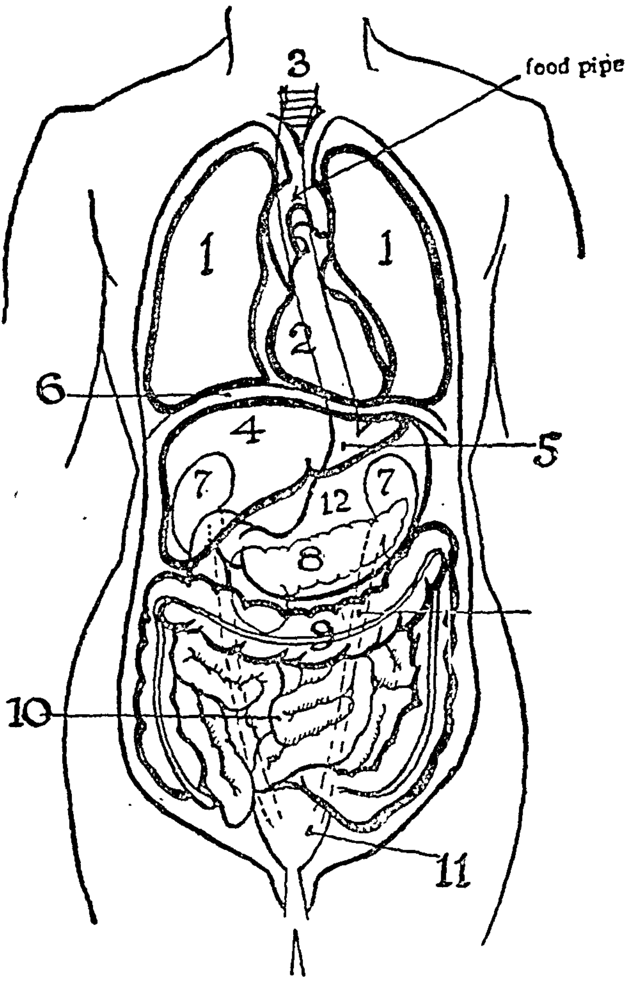


Fig. 5.—The Human Body, showing the contents of the Chest and Abdomen. (1) Lungs. (2) Heart. (3) Windpipe. (4) Liver. (5) (Behind the liver) Opening of Œsophagus into Stomach (12). (6) Diaphragm. (7) Kidneys. (8) Pancreas. (9) Transverse Colon. (10) Small Intestines. (11) Bladder.

(*iii*) The limbs are arranged in two pairs—(*a*) the arms, and (*b*) the legs.

Is the body a machine? Some people are fond of saying that the body is a machine and they compare it with other machines. They have certainly one thing in common : they are both designed to do work, to carry out certain functions ; and to do these, they need a supply of energy which, in human beings, comes from food, in machines from such things as steam, petrol, or electricity. To put it in simple language, an engine such as that of a motor car takes in petrol and air. Thus a car is what is known as an internal combustion engine ; or in other words it derives its energy from burning up something inside it. The car engine burns up petrol and air, in so doing, converts the heat of the explosion into the energy of speed, and the waste products are sent out by the exhaust pipe. The human body takes in food, which is digested by the organs concerned. The digested food is then taken to the muscles, and the muscles burn it up, just as the petrol is burnt up in the car engine. Just as in the petrol engine the burning up of petrol leaves behind many waste products, so the using up of food as energy in the muscles results in the production of waste matters. These waste products are dealt with by the excretory organs of the body.

So far the body might well be compared with a motor car. But this is not the whole story. The greatest wonder of all is, that so long as the body is healthy and fit, all the wonderful processes go on inside it without the owner of the body being aware that any of them are taking place. There are, however, a number of things which go on inside the body which have no place in any machine. For example, a child's body is steadily growing bigger and bigger. Now this growing is something which no machine can ever do. A machine cannot see, cannot hear, and above all, cannot think. The human body may have a certain likeness to a machine but certainly it is more wonderful than any man-made machine.

Life-history. The various vital processes going on in the body constitute life. Failure of the body to perform these vital functions is termed death. Every human life begins its career as a new-born child. While the child was in the womb, it derived its nutrition (food and air) from the mother's body, but immediately after birth it begins to breathe independently and learns to take the mother's milk. The child grows and its organs begin to develop. The brain, skeleton and the reproductive organs begin to mature. This period is called Puberty. At this time secondary sexual characters (such as the growth of hair on the face and the upper lip in males) begin to develop.

The male reproductive organs produce sperms and the female reproductive organs produce eggs. The new individual develops as a result of the union of a sperm and an egg. This is called Fertilisation. The fertilised eggs grows and divides repeatedly till the body of the new child is formed. The new child (it is called foetus while it is inside the mother's womb) attains its full size in about nine months. The child is then born as a result of the contraction of the walls of the womb. The child is still connected with the mother's body through a thick cord (umbilical cord). This is cut and the child is separated.

Death ends the career of an individual. Barring accidents, it comes gradually. With advancing years the various structures of the body slacken and ultimately some organ fails to do its job, and the machine stops. "We must all die sometime."

CHAPTER II

THE HUMAN BODY IN ITS ENTIRETY

Let us now consider the human body as a whole. Taking a large body of men and women, we find that they have certain common gross characteristics.

Size. They all have a generel size. The average adult male is 5 feet 8 inches high, and the average adult female 5 feet 5 inches. The smallest dwarf recorded was 18 inches high The tallest gain was 9 feet and half inch.

Weight. The weight depends upon height, age and sex. The average weight of the adult male is 150 pounds ; of the average female 140. Dantel Lambert weighed 739 pounds, while Calvin Edsin was only 42 pounds.

Span of Life. We have also a certain general span of life. The average span of human life is 70 years. John Parr was 152 years of age when he died. Henry Jenkins lived up to the age of 169 years. But these are exceptions which prove the rule. The variations, as you see, are within very narrow limits. There are no Lilliputians, and no real giants included in the human race. The fact is that the span of life of any individual is largely determined, barring accidents, at the moment when he starts off. Accidents include not only being knocked down by a car, but also being hit by disease germs, or equally getting appendicitis or swallowing sulphuric acid by mistake or intentionally.

Perfectly familiar, as these facts are, their importance is nevertheless vital. They are of great importance to every individual as regards both his future and capacities. A human being is definitely limited in his scope by the limitations imposed by his body—by its size, its weight, its strength, the number of years it will live. Our bodies are traps in which each of us is caught.

The difference between a thin and a fat person is, however, far deeper than the surface, and those differences

have great bearing on their health and disease susceptibilities. The thin man has enormous lungs, so that air does not blow in and out of all his lungs spaces, and these people are liable to tuberculosis.

The fat man, on the contrary, has very small lungs and because he does not breathe in and out a good over-supply of oxygen to burn all the food he eats, it collects in the shape of fat. In the thin man the heart hangs dependent and he seldom suffers from heart or arterial diseases. The fat ones very often suffer from arterial degeneration.

The stomach of the thin man is long and drooping and he is likely to have a heavy feeling and gas after eating. They are, as a rule, dyspeptic. The fat one scores on this point; his stomach is small and high placed and empties easily, hence he enjoys his meals. He is liable to get diabetes, but is seldom constipated.

Thus each has his tendencies, his dangers, and his distresses. The thin one is easily tired but the fat man is cheerful and jovial.

These things are said, of course, in a general way. There are a large number of exceptions. The thin man should, however, realise his shortcomings and take the necessary steps. Daily rest after meals, abdominal exercises, and nourishing food will do him a lot of good. The heavy ones must also adjust their ways of life to the form of their bodies. They must take plenty of exercise, and must learn not to take too much rich food. For them, as for the thin ones, their way of life must be a life-long task.

CHAPTER III

THE SKELETAL SYSTEM

The internal jointed bony framework of the body is called the skeleton. It consists of 206 bones. For the purpose of description, it may be divided into two divisions :—

(i) Axial system including the skull, backbone, ribs and breast bone.

(ii) Appendicular skeleton including the limbs and the girdles.

The Axial Skeletal System :

Skull. On top of the backbone is balanced the skull. It consists of two parts : The brain case (cranium) consisting of several bones fitted very closly together to form a round closed cavity in which the brain is placed and protected ; and the face in which there are light bones with cavities for the eyes, nose and mouth.

The brain case is made up of eight flat bones.

Frontal bone	..	1	(it forms the forehead)
Parietal bones	...	2	forming the sides and roof of the skull.)
Temporal bones	...	2	(situated at the sides and base of the skull.)
Occipital bone	...	1	(situated at the back and part of the head.)
Sphenoid bone	...	1	(situated at the base of the skull and in front of the temporal bones. It looks like a bat with its wings extended.)

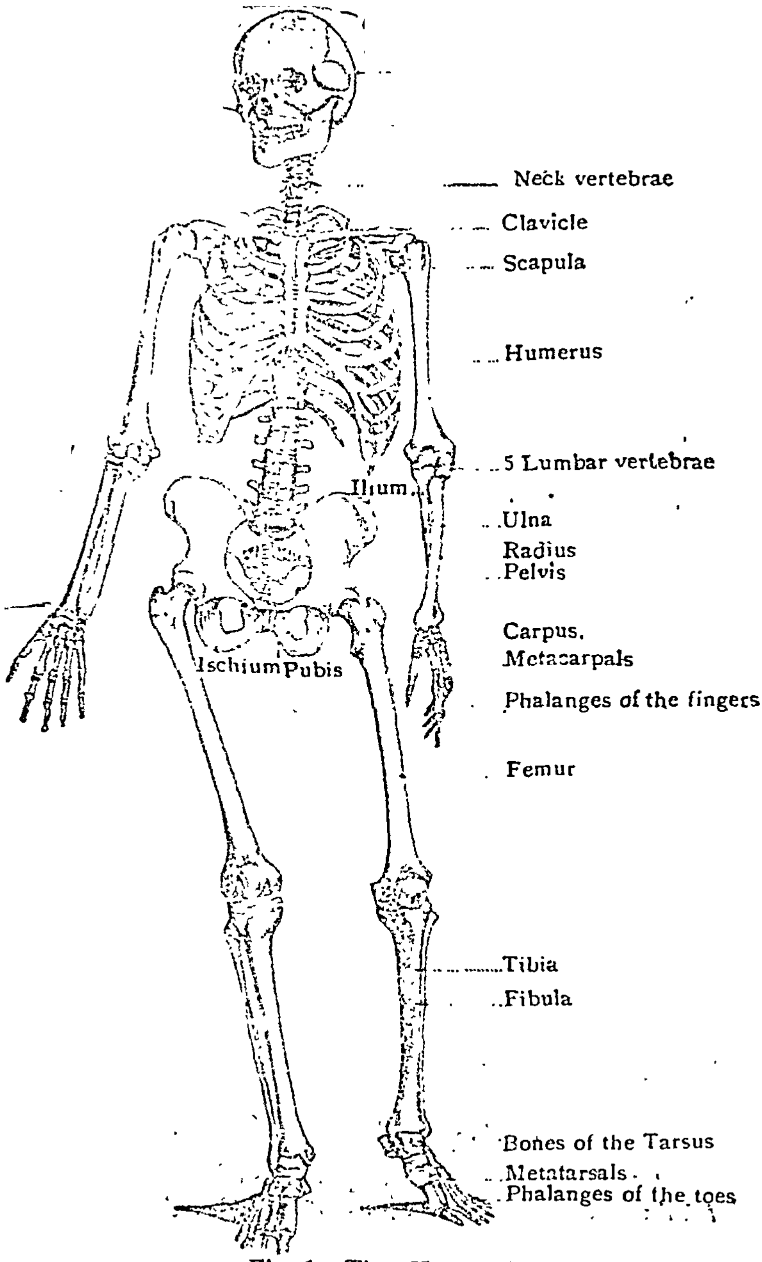


Fig. 6.—The Human Skeleton

Ethmoid bone. 1 (situated in the front part of the base of the skull between the two orbital cavities. It forms the roof of two nasal passages.)

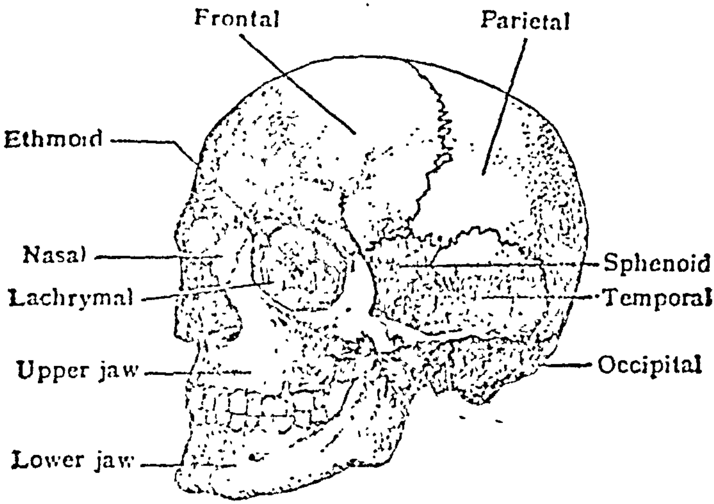


Fig. 7.—The Skull, seen from the left side.

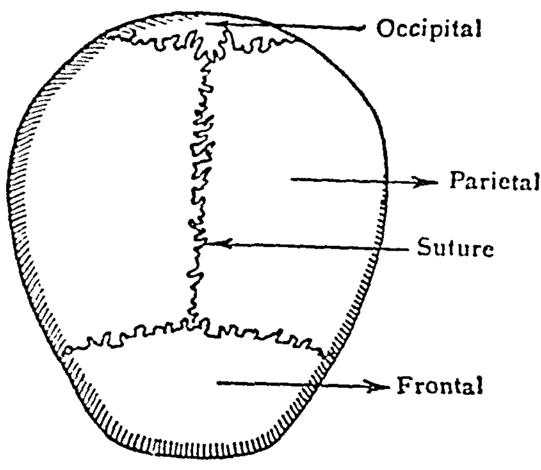


Fig. 8.—Top View of the Skull.

The Face. It is made up of a number of small bones. All these, except the lower jaw, are immovably united to the cranium.

The face bones are as follows :—

(*i*) **Nasal bones** (two) : situated in the middle and upper part of the face. They form the bridge of the nose.

(*ii*) **Superior maxillæ** (two) : they are the upper jaw bones and they are united. They go to form the *roof of the mouth, the floor and outer wall of* the nose and the floor of the orbits. They bear the upper set of teeth.

(*iii*) **Lachrymal bones** (two) : one situated at either corner of the orbit close to the nose. They have grooves for the tear ducts.

(*iv*) **Malar or cheek bones** (two) : they form the prominences of the cheeks.

(*v*) **Palate bones** (two) : they form the back part of the palate and are united in the middle. They form the roof of the mouth.

(*vi*) **Two spongy bones (turbinated bones)** : they are twisted in a scroll like fashion to increase the length of the air passages of the nose.

(*vii*) **The Vomer** (one) : this forms the partition between the two nasal passages.

(*viii*) **The Mandible, inferior maxilla or lower jaw** : this is the strongest and the largest face bone and forms the chin. It forms a hinge joint with the temporal bones and it is the only face bone which is capable of movement. It bears the lower set of teeth.

The skull bones are united together by sutures (Fig. 8). The sutures look like the teeth of a saw and they make the cranium strong and resistant.

The Teeth. In the adult there are 32 teeth, 16 in the upper and 16 in the lower jaw. (Fig. 24).

The arrangement of teeth in each jaw is as follows :—

(*a*)	**Incisors** (for cutting)	4
(*b*)	**Canines** (for tearing)	2
(*c*)	**Premolars** (for grinding)	4
(*d*)	**Molars** („ „)	6
		16

Teeth are made up of a hard substance known as dentine which on the upper part of the tooth is covered over by a shiny and very hard substance called Enamel. Over the lower part of the tooth, the dentine is covered over by hard cement which fixes the tooth in its socket. There is a central cavity in each tooth and this is known as the pulp cavity.

The Back Bone or the Vertebral Column. The back bone or the spine consists of small irregular ring-shaped bones called Vertebræ, of which there are 33 in infancy. In adults, the lowest nine fused, orming two bones known respectively as the Sacrum and Coccyx.

The Sacrum is composed of five fused, vertebræ and forms the key-stone to the pelvic arch (Hip). The Coccyx is usually composed of four small tail vertebræ which are fused together. In some cases these may be 3 or 5. The upper end of the Coccyx is united by a joint to the sacrum.

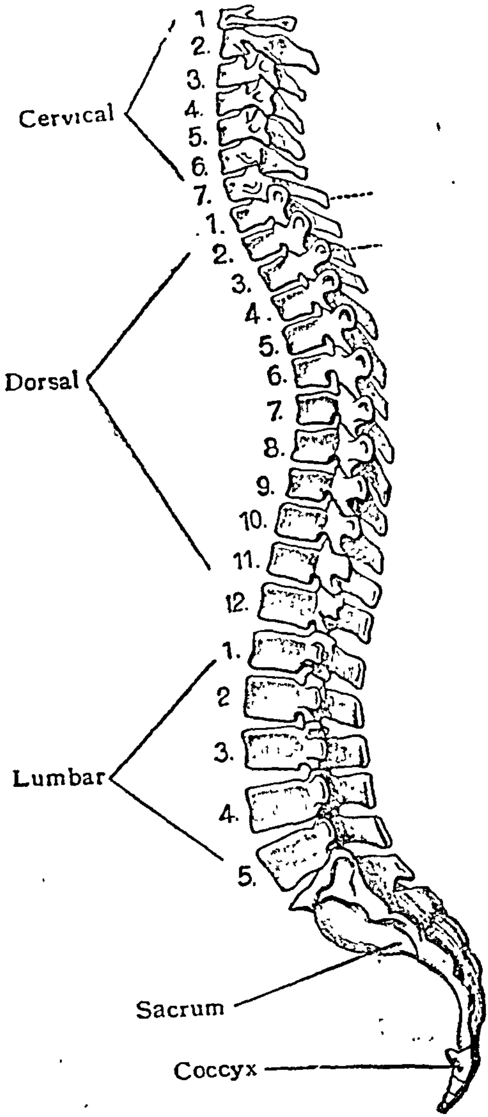


Fig. 9.—The Vertebral Column.

The Vertebrae. They are classified as follows :—

Cervical (Neck)	...	7
Throacic (Dorsal)	.	12 to these the ribs are attached behind.
Lumbar (Lion)	...	5
Sacrum (Hip)		5
Coccyx (Tail)		4

The vertebræ are supported by strong ligaments and muscles and thus a solid pillar is formed which makes it possible to carry heavy loads on the shoulders with comparative safety and ease. In order to prevent injury to the back bone from falls and jerks, rings of padding material are interposed between the vertebræ. They act as shock absorbers.

The vertebral canal is a tube which runs through the greater part of the length of the spine. In this canal the spinal cord connected with the brain is located and protected from injury.

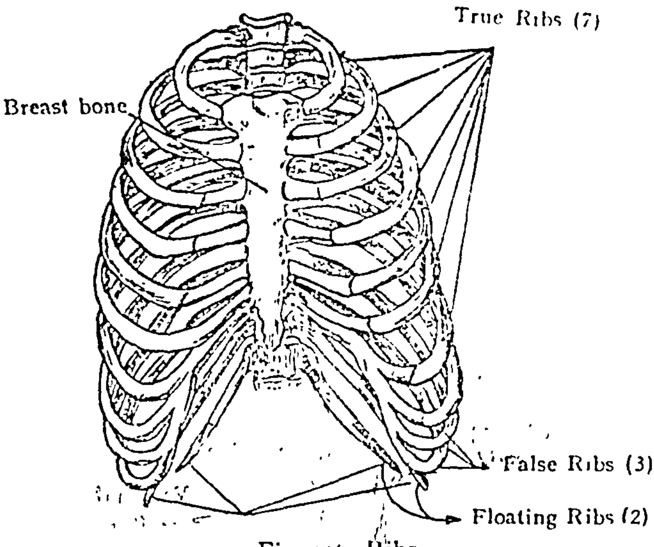


Fig. 10—Ribs.

The Ribs. There are twenty-four ribs, twelve on each side. They are all attached to the spine. The first seven

(true ribs) are connected with the breast bone by long pieces of cartilage. The next three (false ribs) are attached to each other in a similar fashion and indirectly to the breast bone. The last two ribs do not reach the breast bone and are free in front. There are, therefore, called the Floating ribs.

The Sternum (**Breast bone**). It is a flat bone about six inches in length. It is broad at the top and narrow at the base. To its upper surface are attached the collar bones (clavicles). On either side it has a depression where the costal cartilages of the seven true ribs join it.

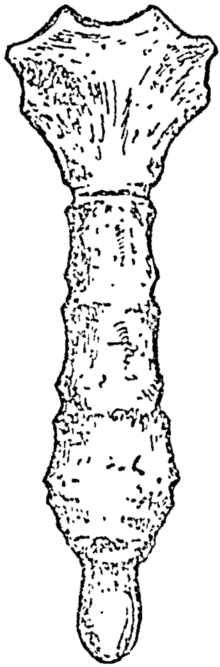


Fig. 11.—The Breast Bone.

The Thorax. The ribs, breast bone, and that part of the back bone with which the ribs are joined form the thorax (chest cavity). See Fig. 4.

The Appendicular Skeleton.

The Limbs consist of the arms and legs.

The upper limbs consist of the shoulder blade, collar bone, upper arm, forearm and hand.

The shoulder blade (Scapula) is a large flat triangular bone lying on the outside of the upper ribs at the back of the thorax.

Fig. 12.—The Scapula.

The scapula is attached to the ribs only by means of muscles, and is thus freely movable over the chest. It has a conspicuous ridge extending across its back and a shallow cavity known as the Glenoid Cavity at its outer angle. The head of the upper arm bone (humerus) fits into this cavity. Thus the range of movement of the arms is very great because the head of the humerus which is rounded moves in a cup-shaped depression in the Scapula (glenoid cavity) thus forming the "ball and socket" joint.

The Clavicle (Collar bone) is S shaped. The inner end joins the breast bone and the outer end articulates with the process of the Scapula.

The upper arm bone (Humerus): This is a long narrow bone and its upper end is rounded. This is called the head and it fits into the glenoid cavity of the scapula forming the shoulder joint. Its lower end is expanded and fits into a

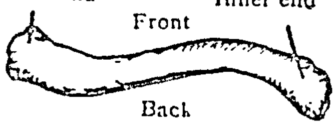


Fig 13 – The Calvicle.

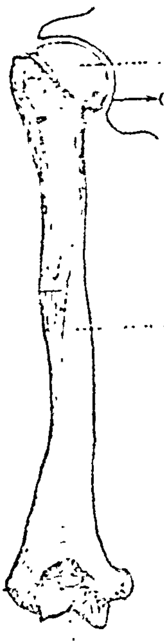


Fig. 14.—The Humerus.

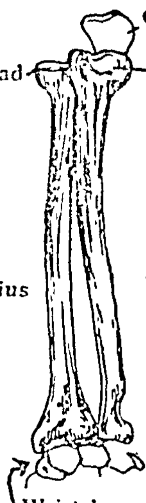


Fig. 15.—The Radio-Ulna.

cup-shaped socket formed by the upper ends of the forearm bones (radius and ulna) to form the elbow joint.

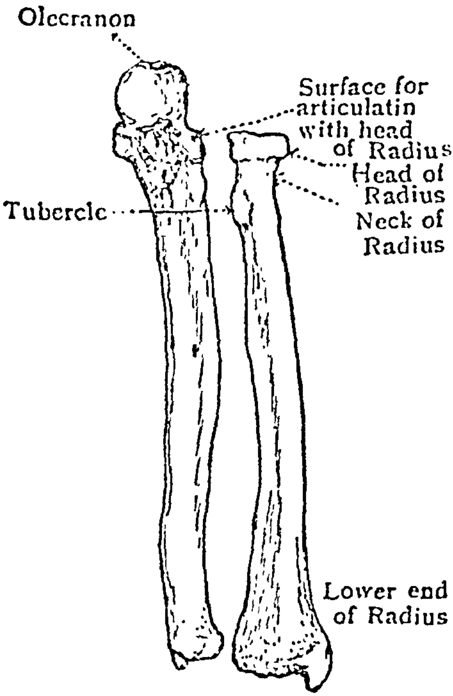


Fig. 16.—The Ulna and Radius, separated.

The Forearm. It has two bones—**Radius** and **Ulna.**

The Radius is outer and in line with the thumb and the Ulna is inner and in line with the little finger. The **Radius** is shorter than **Ulna.** The pointed end which is felt at the elbow is formed by the hook shaped end of the Ulna.

The upper end of the **radius** is rounded and is called the head Its lower end expands just above the wrist and articulates with the wrist bones. The **ulna** is longer than the **radius.** Its upper end is hollowed out and fits in the pulley at the lower end of the humerus.

The Wrist (Carpus) contains eight bones (**Carpal bones**). These are arranged in two rows. The upper row articulates with the lower end of the radius forming the wrist.

The Palm (Metacarpus) contains five metacarpal bones.

The Finger bones (Phalanges). - They are 14 in number Each finger has three phalanges with the exception of the thumb which has only two.

The finger, palm and the wrist bones are all joined by strong and flexible ligaments and his arrangement gives a great amount of elacticity and strength to the hand. The upper limbs have been described " the faithful ministers of the mind "

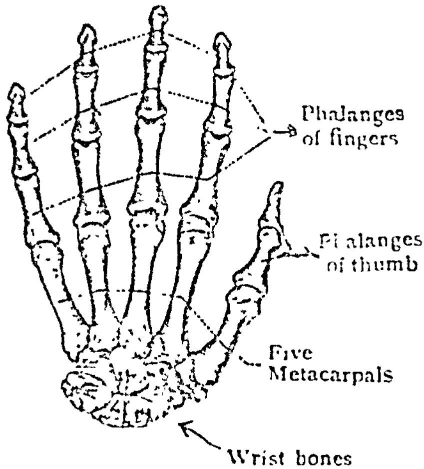


Fig. 17.—Wrist, Palm and Finger bones.

The lower limbs consist of the hip-girdle (Pelvic girdle), thigh bone (Femur), lower leg and the foot.

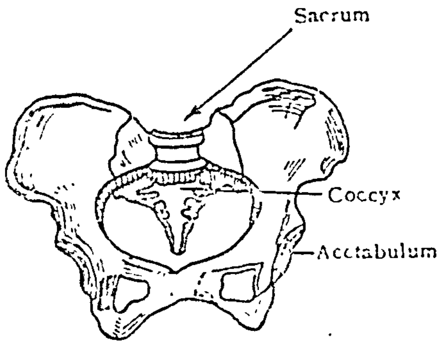


Fig. 18.—The Hip-Girdle.

Hip-Girdle.—The pelvic bones are the strongest in the body. They are united to the sacrum and together form the basin or the pelvic cavity.

On the other side of each hip bone is a cup-shaved cavity the **acetabulum** in which the head of the thigh bone fits to form a **ball and socket joint.**

The **Thigh bone (Femur)** is the longest and thickest bone in the body. It has a rounded end which fits into a cavity in the **hip girdle.**

The lower end is expanded and has two smooth **condyles** which articulate with the **tibia** to form the knee joint. This joint is covered by a small bone which is called the **knee cap (Patella).**

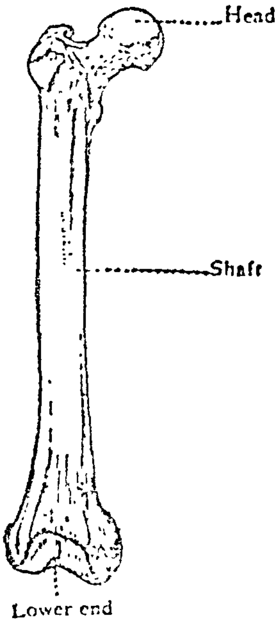


Fig.119.—The Femur.

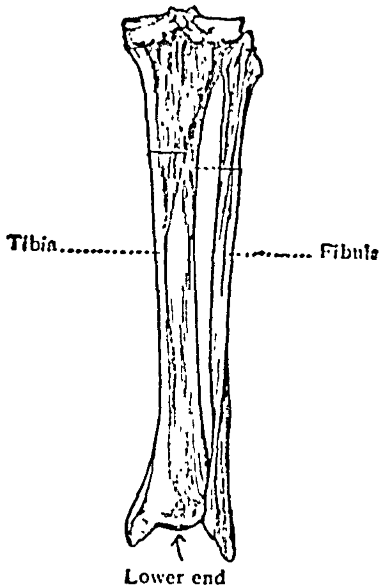


Fig.120.—The Tibia and the Fibula.

The lower leg contains two bones; they are placed side by side. One of them the tibia lies on the inner side (large toe side). This is longer than the other lower leg bone, the fibula. The fibula lies on the other side (little toe side).

The **Foot** consists of three parts :

(*a*) **The ankle (Tarsus)** contains 7 bones the tarsals.

They form the ankle, heel and a part of the sole of the foot. Two of them Astragalus and Os calcis are important.

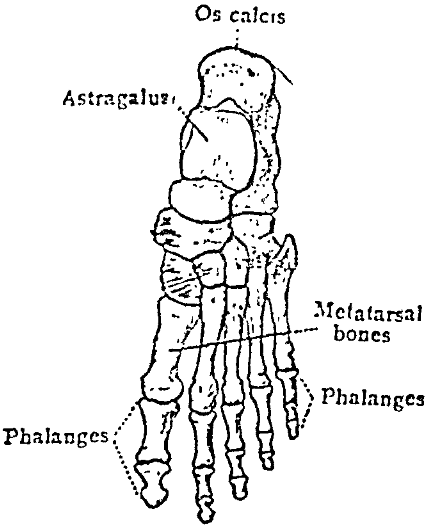


Fig. 21.—The Foot.

Astragalus is the second longest bone of the foot, and has on its upper surface a smooth pulley-shaped surface which joins the lower end of the tibia.

Os calcis is the largest of the tarsal bones and projects backwards to form the heel. This bone bears most of the weight when a person is standing. The remaining five tarsals form part of the instep.

(*b*) **The sole of the foot** (**Metatarsus**) has bones called **the Metatarsals.**

(*c*) **The toe bones** (**Phalanges**) are 14 in number (3 in each **toe**, and 2 in the big **toe**).

The tarsal bones form the strong arch of the foot. This is called the **Plantar Arch.** It enables the foot to support

the heavy weight of the body.

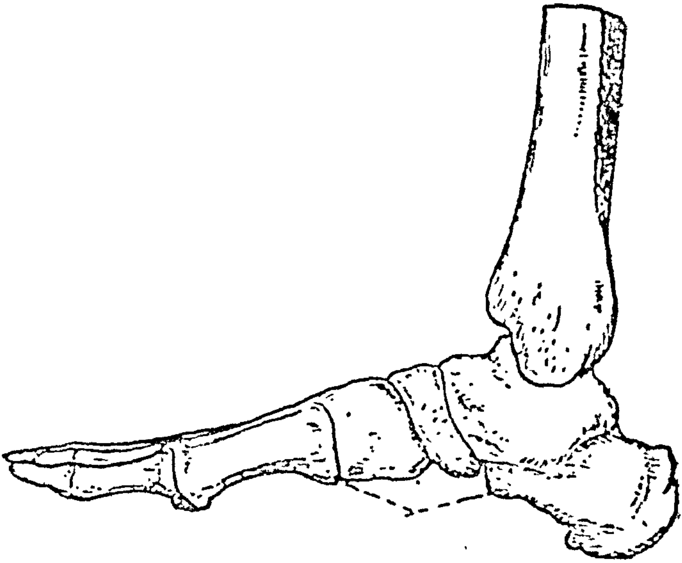


Fig. 22.—Plantar Arch.

CHAPTER IV
THE DIGESTIVE SYSTEM

The organs and process of digestion. Before we can make use of our food, it must be digested. Digestion is the

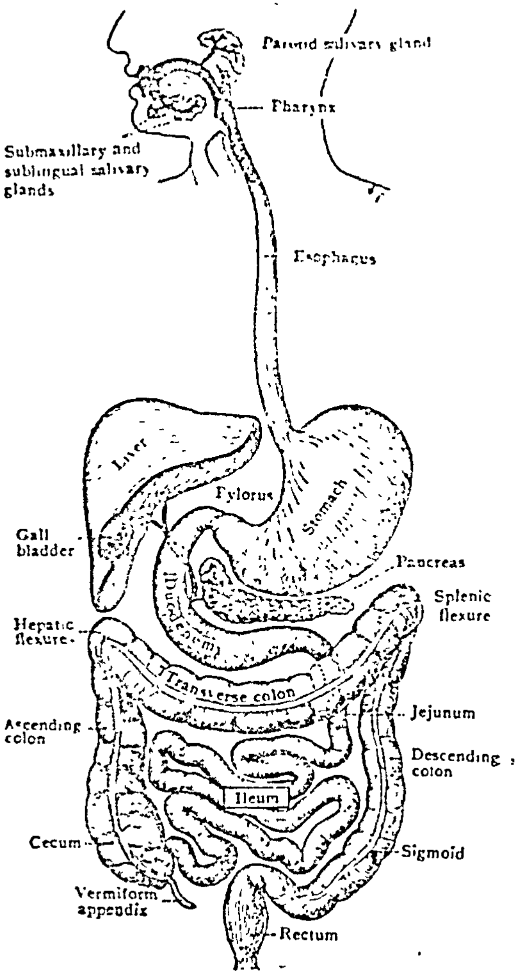
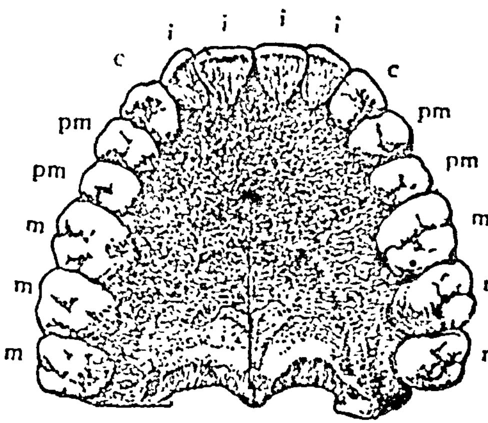


Fig. 23.—The Digestive System.

process by which the food is rendered into a proper condition for absorption by blood vessels and other structures in the walls of stomach and intestines. In other words the preparation of the foodstuffs to suit the needs of the tissues is known as digestion, and this process is carried on in the food canal.

The Digestive system (Alimentary system) consists of a long muscular tube which begins at the **mouth** and opens outside at the **anus**. This tube is thirty feet long, and connected with it by ducts are other important organs, such as salivary glands, liver and the pancreas. This tube is known as the **Alimentary Canal.**

The Alimentary Canal. It consists of mouth ⟶ pharynx, ⟶ oesophagus (food pipe or gullet), ⟶ stomach, ⟶ small intestine, ⟶ large intestine, ⟶ rectum and ⟶ anus.



i —incisors
c —canines
Pm—Premolars
m—molars

Fig. 24.—The arrangement of the teeth in a normal adult.

Mouth. Inside the mouth are found the following :— Teeth, tongue, salivary glands which form the saliva (*Thook*), and the soft palate which forms the back part of the roof of the mouth and ends in the uvula (a small tongue-shaped structure seen at the back of the throat). The tonsils are situated on either side of the throat.

The teeth begin to appear in infants when they are about six months old. The first set of teeth known as the temporary or milk set consists of 20 teeth. The milk set is ultimately replaced by the permanent set which consists of 32 teeth.

The Tongue. It is made up of muscular tissue and it can be moved about in any direction. It is by the tongue that the food is rolled about in the mouth and mixed with saliva during the process of chewing. It also helps in the process of swallowing. On the surface of the tongue are found little pimples and these are called Taste buds.

The Salivary Glands. The large glands of the mouth secrete saliva and the smaller glands produce mucus. Saliva contains a ferment called ptyalin which converts starch into grape sugar. The saliva also dissolves solid particles of sugar and salt. Normally over twenty ounces of saliva is secreted daily.

Pharynx. It is a funnel-shaped cavity in which are situated the openings of the nostrils, the eustachean tubes from the ears and the upper end of the windpipe.

Oesophagus (food pipe or gullet).—It is about ten inches in length and lies behind the wind pipe. As the food reaches the oesophagus, the muscles all along its length contract one after another in a wave. Thus our food does not drop into our stomach suddenly. It is passed down the food pipe by a series of worm-like movements caused by the action of the muscles in the walls of the gullet.

The **stomach** looks like a pouch which is larger at one end than the other. The entrance of the oesophagus into the stomach is situated near the heart and is called the cardiac opening.

The out-let from the stomach is known as the **pyloric aperture.** The gullet opens into stomach near the middle.

The inside of the stomach is lined with a soft membrane in which there are a large number of minute Peptic glands which produce a liquid called the gastric juice.

The **gastric juice** among other things contains hydrochloric acid and pepsin and rennin, both of which are ferments. It is mainly by means of these substances that digestion is carried out in the stomach. The food is mixed with the gastric juice. This is done by the movements of the stomach wall caused by the action of certain layers of muscles in the same way as the food is mixed with a saliva in the mouth by the movement of the tongue.

The **gastric juice** is responsible for digesting nitrogenous food, such as meat, white of an egg, etc.

The food digested in the stomach is changed into a substance called chyme. During the process of digestion in the stomach, the nitrogenous food particles are converted into peptones. The peptones and sugar, salt and other substances are partly absorbed in the stomach and partly in the intestines.

The **Intestines** are divided into :—

(*a*) **small intestine**

(*b*) **large intestine**

The small intestine is a tube which is about twenty feet long. It lies coiled up in the abdomen (Fig. 23). The first portion of the small intestine is known as the duodenum ; and this is about ten inches long. Into the duodenum enter the bile which is formed in the liver, and the pancreatic fluid which is formed in the pancreas.

The **pancreas** is about seven inches long and one and a half inches wide. When the **chyme** passes from the stomach into the **duodenum** it becomes mixed with the **pancreatic juice and bile.** The **pancreatic fluid** helps to complete the digestion of starchy food.

The **pancreatic fluid** contains the following three ferments :—

(*i*) **steapsin**—this mixes with fats and oils making a fine emulsion which is easily absorbed.

(*ii*) **trypsin**—this converts nitrogenous food into peptones.

(*iii*) **amylopsin**—this converts starch into sugar.

The small intestines have a number of minute structures called villi containing blood vessels which absorb the digested food, and also numerous small glands which secrete the *intestinal juice*.

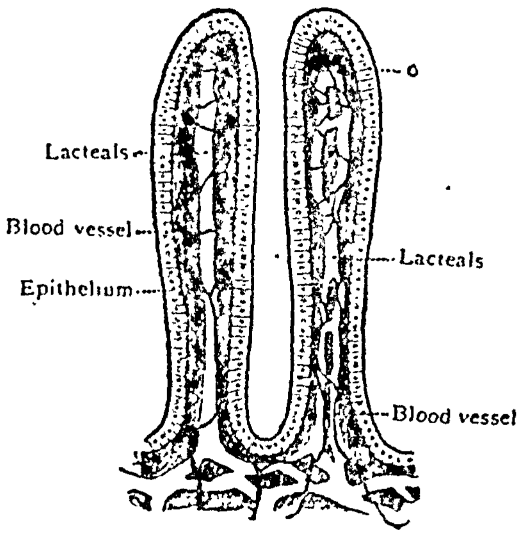


Fig. 25.—Two Villi.

The Liver. It is the largest gland in the body weighing from 40 to 60 ounces and is dark red in colour. It is located immediately below the diaphragm towards the right side of the body cavity. It is divided into two unequal lobes, the right or the larger lobe is further indistinctly divided into three parts and the left or the small lobe into two. On the under surface of the liver is situated a pear-shaped pouch containing bile. This is the Gall Bladder.

The Liver is made up of numerous small cells which secrete bile. The amount of bile secreted daily is about 40 ounces. The bile is carried in a number of small tubes called bile ducts. These tubes open into a single large duct

which pours its contents into the duodenum. If there is any obstruction in this duct, the bile gets absorbed by the blood

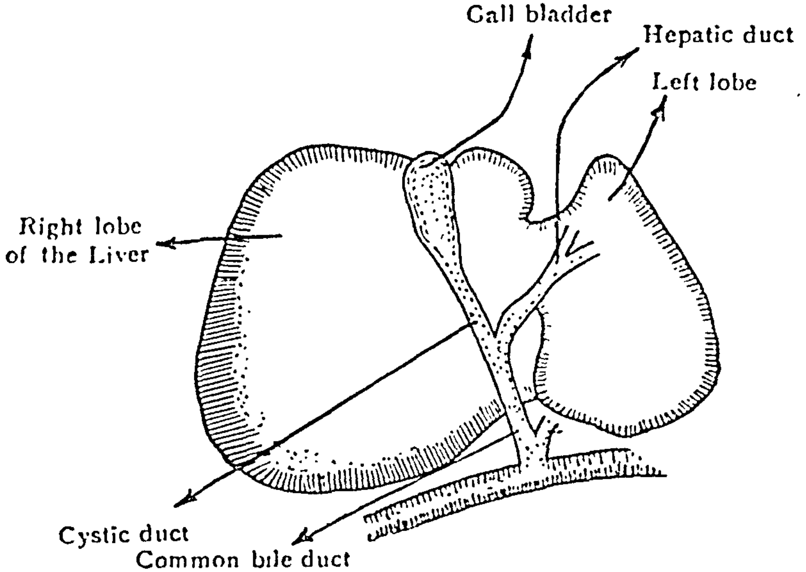


Fig. 26.--The Liver.

vessels in the liver and is carried along with the blood to the various parts of the body giving rise to jaundice (*Pilia* or *yarqan*).

Functions of Bile :

(1) It emulsifies fats.

(2) It prevents food from decomposing and forming gas.

(3) It helps the digested food to pass smoothly along the digestive canal.

(4) It is ultimately partly absorbed by the intestine, gets into the blood and helps to keep up the heat of the body.

A substance called animal starch (**Glycogen**) is manufactured in the liver in large quantities. Glycogen gets changed into sugar. Sometimes the sugar thus formed is so great in quantity that it cannot all be used and the extra quantity passes out of the body in the urine. Diabetes is due to this cause.

Large intestine (*colon*). Close to the junction of the small intestine with the large intestine is a small pouch leading out of the colon. This is called the cæcum. From the cæcum comes out a little worm-like blind tube known as the Vermiform appendix. The inflammation of the appendix produces the disease called Appendicitis.

The large intestine absorbs much of the fluid which remains after digestion.

Rectum. This is the last part of the alimentary canal. The undigested remnants of the food are carried from the colon to the rectum and ultimately out of the body through the anus.

It takes 24 to 36 hours for the food to make the entire journey through the alimentary canal.

The process of Absorption. After the food is properly prepared, it is absorbed into the lymph vessels and blood vessels surrounding the wall of the small intestine. With the absorption of these last products into the tissue juices, the function of digestion ceases.

The chemical changes occur in the three main food stuffs—carbohydrates, proteins and fats—during digestion. The process is a continuous simplification, breaking them into more and more elemental chemical structures. When they reach the final stage, they are absorbed. The proteins and the starches are absorbed through the walls of the intestine into the net-work of small veins which ramify over its surface. They empty into larger and larger veins and are carried at last to the liver.

Besides the blood vessels, there are, however, other absorbent vessels on the surface of the small intestine. They are white, fine threads, which are called Lacteals because they are always concerned with the absorption of milk and because their contents, the Lymph, has a milky appearance. They absorb largely fats ; sometimes the excess of protein. They do not empty into liver, but merge together into larger and larger lymph trunks until the thoracic duct is formed which runs upwards along the backbone and discharges its contents into the blood stream, joining one of the large veins at the root of the neck.

Absorption in the Bowel. During the food's journey in the bowel, all the digested part of the food gets absorbed—the sugar and the amino acids into the liver *via* the blood vessels, the fat into the lymph vessels, and the undigested residue passes on into the colon. The chief action of the colon is to abstract most of the remaining water from its contents, and the solid residue is discharged, thus completing the whole process.

Assimilation. It will be easy now to perceive the way in which the body tissues use these foodstuffs, and the method whereby they are used in individual cell absorption.

As the amino acids enter the liver, they are mixed with unpurified protein matter that has been formed by the action of the gastric juices on the protein.

The liver acts upon the sugar in a remarkable way. The sugar is turned into glycogen (animal starch) which is stored by the liver in this form.

As the body requires sugar for energy purposes, the liver re-converts the glycogen into sugar, which is carried by the blood stream to the cells, and finally passed away in the form of carbon dioxide and water.

At any time, then, the blood contains purified amino acids, fats as oily particles, and sugar—all for the purpose of assimilation by the cells.

As the blood flows completely round the body in about one minute, the process of assimilation must take place rapidly. Until the blood reaches the capillaries, not a single drop of food passes out The walls of the arteries are too thick to allow this, but the capillaries have only one thin wall, which is bathed by the lymph of the adjacent lymph vessels.

The flow of blood in the capillaries is slow—hence the cells have time to extract food and oxygen from the blood.

The red blood corpuscles in the blood stream give up their oxygen to the tissues ; and, in return, the tissues pass out to the blood carbon dioxide and water, thus causing the blood, on its return *via* the veins to the heart, to lose its bright red colour. The blood, therefore, on its return rom the tissues, has lost most of its food and oxygen, and is of no use until it has returned to the lungs and digestive tract to be replenished.

CHAPTER V

THE CLASSES OF FOODSTUFFS

Food is required for :—

(1) Maintaining the normal heat of the body.

(2) Supplying energy for external and internal work.

(3) Repairing the wear and tear of the body.

(4) Supplying the material for the growth of the body.

All the foodstuffs are found to contain one or more of the following substances :—

(*a*) Proteins (nitrogenous foodstuffs or albuminates). The animal proteins are found in meat, fish, eggs, milk and cheese. The vegetable proteins are found in peas, beans, wheat and pulses.

Generally speaking protein derived from vegetable food is of less value than the protein derived from animal foods. The proteins build up the body and repair the worn out parts. A grown-up man requires 3½ ounces of first class protein every day.

(*b*) Carbohydrates are the body's chief source of heat and energy.

The chief sources of supply from which we obtain our carbohydrates are the following :—

(*i*) Sugar and honey.

(*ii*) Starch (potatoes, cereals, rice, vegetables, fruits, etc.). The average diet of an adult person should contain about 14 ounces of carbohydrates daily.

(*c*) Fats include all oils and fats, such as 'ghee,' animal fat, olive oil, cocoa-nut oil, and other vegetable oils. They are used in the body as fuel. The heat produced by fats is twice as much as produced by carbohydrates. Fats are therefore good

for people doing hard physical work or living in cold climates. They also help to make the body strong and act as a source of energy. The minimum amount of fat needed daily by an adult is 3 ounces.

(*d*) Salts are very essential articles of food, for they play an important part in the building up of our body. The following salts are useful :—

(*i*) Common table salt is used very largely. It helps in the production of hydrochloric acid which is an important part of the stomach juice.

(*ii*) Calcium salts—they help to build the skeletal system.

(*iii*) Potassium salts are found in fresh fruits and vegetables. They purify the blood.

(*iv*) Magnesium salts are found in all foodstuffs and they also purify the blood.

(*v*) Iron salts—deficiency of these salts causes anaemia. Besides these mineral salts there are organic salts such as tartrates and citrates chiefly contained in fruits and vegetables.

(*e*) Water—three to five pints of water are lost from the body every day through urine, sweat and expired air. This must be made up by drinking water and watery substances. Water forms about two-thirds of the weight of the body. It performs the following functions :—

(*i*) It serves to dissolve the digested food and thereby helps in obsorption.

(*ii*) It keeps the blood flowing and helps in the removal of the waste products from the body.

(*iii*) It helps in keeping the body temperature at normal level in hot weather.

The following table gives the divisions of foods into foodstuffs :

- FOOD
  - inorganic
    - water
    - mineral salts
  - organic
    - nitrogenous foods (proteins and albuminoids)
    - non-nitrogenous foods
      - fats
      - sugar and starch
      - vegetable acids

(*f*) Vitamins—without vitamins all our food is useless. They are known as life-giving substances and they include all those constituents which are essential to proper chemical changes in digestion and nutrition. Their absence from food causes "deficiency diseases," such as beri-beri.

Five different kinds of vitamins are known to exist and there appear to be others. These five are called Vitamins A, B, C, D and E, respectively.

Vitamin A is found in butter, milk, fats, egg yolk, green vegetables and cod liver oil. Deficiency of Vitamin A in our food would cause rickets and it is also the cause of infection of throat and lungs.

Vitamin B is found in green leafy vegetables, cereals, pulses, nuts, milk, eggs, liver, potatoes and carrots. It is soluble in water. A lack of this vitamin is responsible for producing intestinal disorders and it also causes beri-beri.

Vitamin C is obtained from green vegetables, fruits, egg yolk and is also found in small amounts in milk. It is soluble in water and is often damaged by cooking. A lack

of this vitamin causes scurvy (loss of weight and muscular weakness).

Vitamin D is found in fats, such as cod liver oil, butter and in milk and eggs. It is essential for the development of bone and its deficiency would cause rickets.

Vitamin E.—It is supposed to promote fertility and the production of milk. Not much is known about this vitamin.

Thus you will now understand that it is wise to include milk, pulses, fresh green vegetables and fruits in the daily diet.

CHAPTER VI

THE CIRCULATRY SYSTEM

The blood is red fluid and weighs about one-twentieth of the weight of the body.

The composition of the blood is as follows :—

(*a*) A colourless fluid called Plasma.

(*b*) Solid particles called corpuscles floating in plasma. The corpuscles are of two kinds—the red blood corpuscles and the white blood corpuscles. The blood is red because it is laden with red blood corpuscles. The red blood corpuscles look like small round discs and are present in very large numbers. The white blood corpuscles are much fewer in number than the red blood corpuscles. They are in the proportion of 1 to 500 of the red blood corpuscles. They have no definite shape—always changing. R·B C· – 6 m. p.c mm
W·B C – 6 T · p c.mm

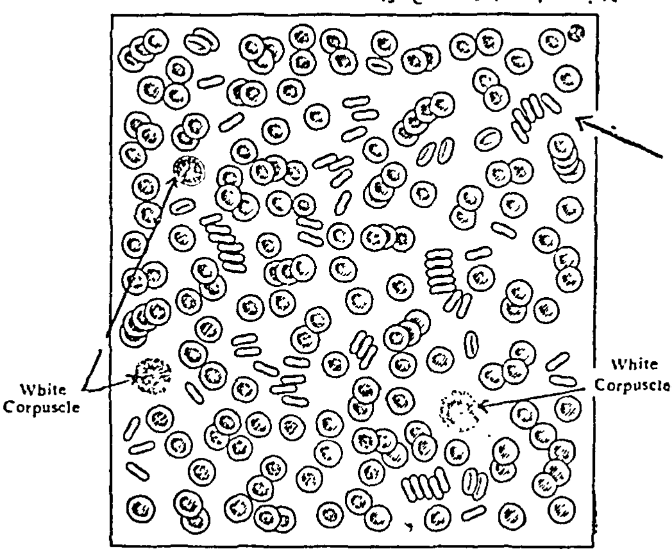


Fig. 27.—A drop of blood under the miscroscope.

They form a kind of police, and like good soldiers, they defend the body from the attacks of disease germs.

When the body is invaded by some disease germs, they run up to the spot travelling by the blood stream and eat them up. Sometimes the invaders are too strong for the white blood corpuscles which are killed and become pus cells.

Functions of the blood. 1. It acts as a carrier of oxygen to the various parts of the body.

2. It is the medium by which food is supplied to all the parts of the body.

3. It takes away the waste products of the body to the different organs which excrete them.

4. It also brings the necessary mineral salts to the body.

5. It carries the secretions of the ductless glands to the proper parts.

6. It carries the 'police force' of the body (the white blood corpuscles) to the part where it is required.

7. It keeps our bodies warm, maintaining a uniform temperature of about 98·4° F.

Clotting of Blood. When blood is shed, it turns solid or clots. If blood from an animal body be collected in a dish, it becomes solid in a short time. In a few minutes the clot gradually shrinks and a clear yellow fluid appears on the surface of the clot. This liquid is called Serum.

The capacity of the blood to clot is very useful in closing up cut blood vessels and preventing bleeding.

The Circulatory System consists of the heart, arteries, veins and capillaries.

The Heart is a hollow muscular organ. It is conical in shape with the base upwards and the apex downwards. It is situated in the chest cavity behind the sternum and to the left of the middle line of the body. (See Fig. 5.) It is about 10 ounces in weight.

The heart is divided into two halves by a muscular

partition—right half and left half. The two halves do not communicate with each other.

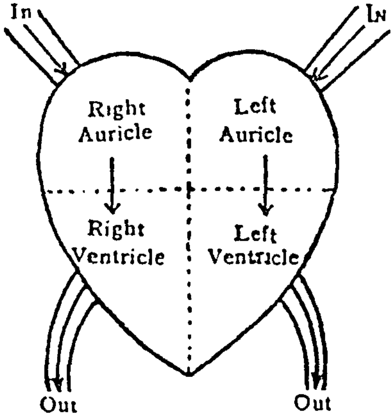


Fig. 28.—The Heart—a four-chambered structure.

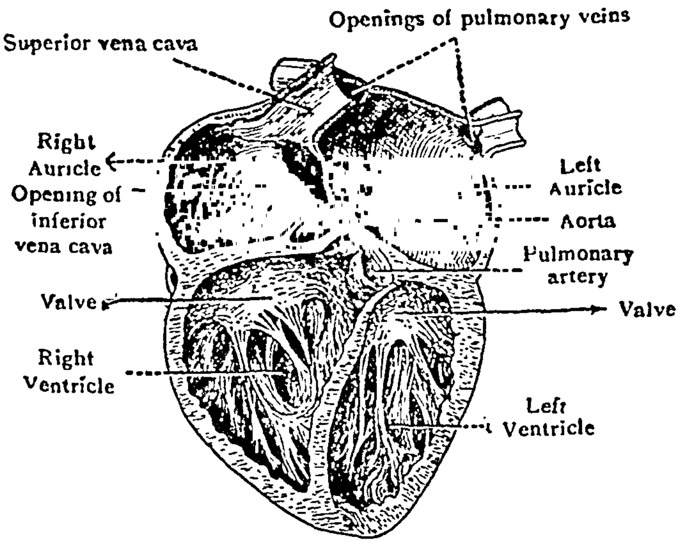


Fig. 29.—The Heart showing its chambers.

The left half of the heart contains pure blood and the right half contains impure blood.

Each half is again sub-divided transversely by another muscular partition into an upper and a lower portion. Thus there are two upper chambers called the right and left Auricles and two lower chambers called the right and left Ventricles.

The right auricle and the right ventricle are in communication with each other and so are the left auricle and the left ventricle.

The openings between the auricles and the ventricles are guarded by doors (valves) which only allow the blood to flow from the auricle into the corresponding ventricle and not in the opposite direction.

The heart therefore is a four-chambered structure. The walls of the left side of the heart are thicker than the walls of the right side.

The heart contracts rhythmically about 72 times per minute. It contracts and then relaxes at regular intervals. The left side of the heart is a much more powerful pump than the right side.

and lymphatics

The Arteries and Veins and Capillaries. The blood circulates in the body through a system of closed tubes called blood vessels.

The arteries are blood vessels which take the blood from the heart and distribute it to the various parts of the body. An artery arises as a big blood vessel from the heart and as it runs its course, it branches repeatedly and ultimately breaks up into an extensive system of network of very fine tubules in an organ. These extremely fine tubules into which the blood vessels are divided are called the Capillaries.

From the various parts of the body the blood is sent back by capillaries which join to form blood vessels. These, during their course, join other similar vessels which enter the heart. These are known as the Veins.

A vein, since it takes back blood from an organ, arises as a set of capillaries and ends in a big blood vessel which reaches the heart.

Veins are, therefore, vessels which convey the impure blood to the heart from which it passes to the lungs to be purified.

The Arteries are blood vessels which take the blood from the heart to the capillaries and the veins take it back from the capillaries to the heart.

The walls of the arteries are very elastic and thick because they have to make room for the extra blood which the heart pumps into them at every beat.

This is the reason why when you put your fingers on the pulse (an artery at the wrist) you feel with every heart beat a sudden bulging of the artery beneath your fingers.

The veins are much thin walled and have little pocket like valves to prevent the blood from falling back.

The Action of the Heart. The heart is a central pump and its action is marked by an alternate contraction and relaxation of its muscular walls. If you press your hand on your chest in the region of the heart you will be able to feel its beats. At first the two auricles contract at the same time and immediately afterwards the two ventricles contract simultaneously. Then there is a pause during which both the auricles and the ventricles relax. This process is regularly repeated.

When the auricles contract the blood is forced into the ventricles and when the ventricles contract, the blood from the right ventricle goes into the Pulmonary artery and from the left ventricle into the Aorta.

The heart thus acts as a Double Pump. It pumps the pure blood from the left ventricle into the aorta and from the right ventricle into the pulmonary artery and thence to the lungs.

The blood is purified in the lungs and is returned to the left auricle through the pulmonary veins.

It is interesting to note that the heart is continually pumping about six seers of blood through the arteries and although only about ten ounces in weight, the heart pumps about 12,000 tons of blood in fifty years' time.

The Course of Circulation. Let us now follow the blood stream in its journey round the body.

Starting with the left side of the heart, the left ventricle sends the blood into the big artery called the Aorta The aorta gives off branches, which divide and sub-divide and supply all the organs and tissues in the body except the lungs.

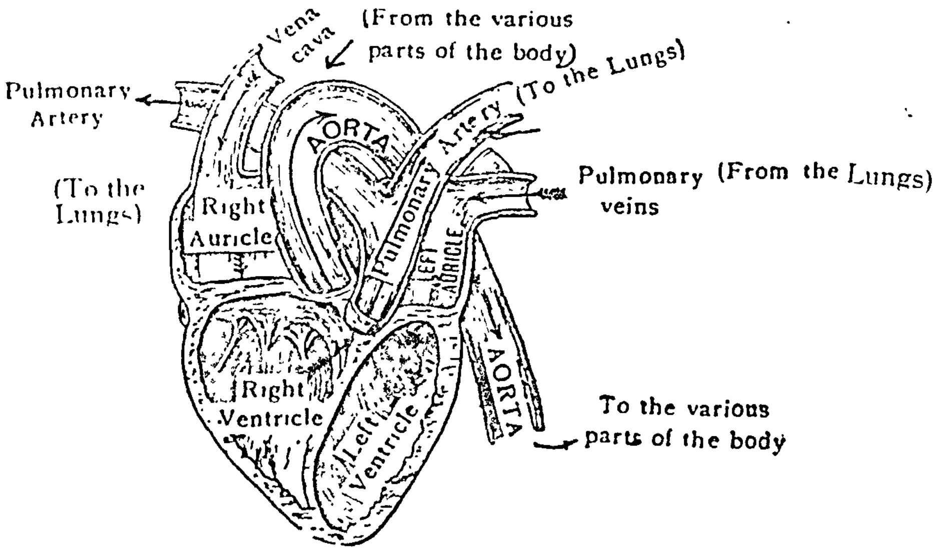


Fig. 30.—The Heart.

After travelling through the capillaries it returns by the veins to the right auricle. The blood returning from the intestine and stomach does not go straight back to the heart ; it is carried by the Portal Vein to the liver where it passes through a second set of capillaries before it is finally returned to the right side of the heart by the Vena Cava.

The blood coming from the digestive tract is full of foodstuffs and the liver picks up the starchy food and stores it away to distribute it in smaller doses as required.

Arrived at the right side of the heart, having been robbed off much of its oxygen by the tissues, the blood is next sent to the lungs by the pulmonary artery and is there recharged with oxygen and returned to the left auricle through the Pulmonary Veins to begin its journey anew.

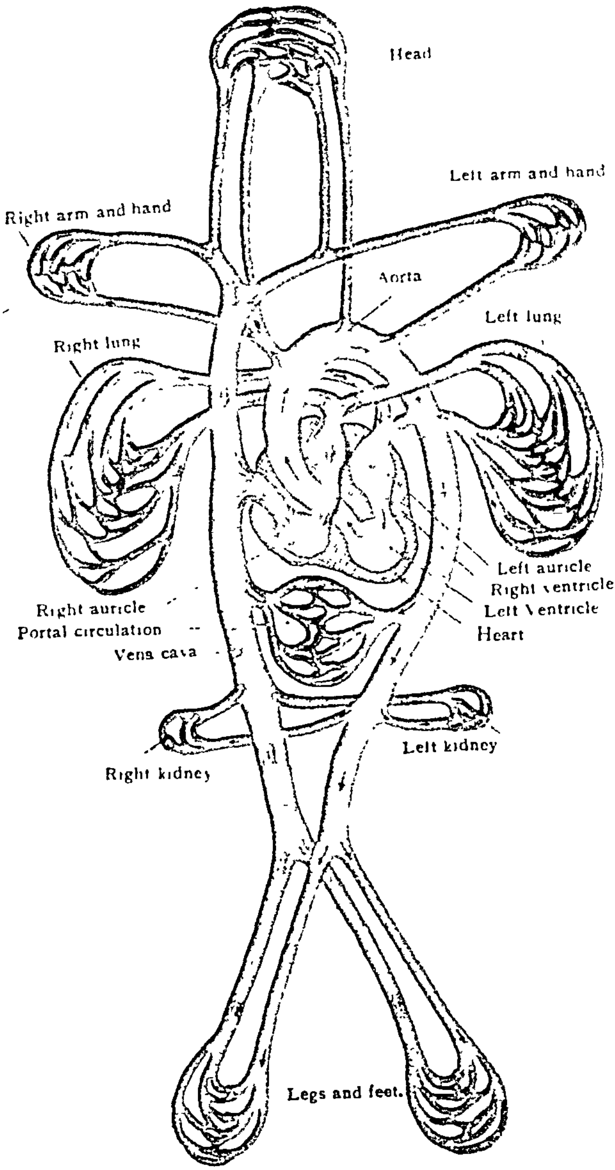


Fig. 31.—The Heart and the blood vessels.

CHAPTER VII

THE RESPIRATORY SYSTEM

Respiration or breathing is the process by means of which the blood is purified in the lungs by giving up its carbon-dioxide and taking in oxygen.

The muscles get the energy for the work they do by burning sugar and not only the muscles but all the various parts of the body live by burning (oxidation). Burning only takes place if oxygen is present; and so a constant and sufficient supply of oxygen is the first necessity for life.

As carbon is always one of the elements burned, there is also a steady production of carbon-dioxide.

The body can be deprived of food and salts for a few weeks: You can live without water for say 60 or 70 hours according to the condition of the surrounding atmosphere: but you cannot live without oxygen for more than a few minutes.

Normally it is hard to hold the breath for more than about three minutes. Even that is difficult and can only be done by some individuals.

One-fifth of the atmosphere is made up of oxygen and we get our oxygen supply from the air by way of our lungs. The oxygen having been taken up by the blood is then carried on to every part of the body. The carbon-dioxide which is made in the cells is taken up by the blood and carried back to the lungs. This is the complete process of respiration which is actually carried on in two stages.

The first or External Respiration takes place in the lungs where oxygen is taken up and carbon-dioxide given out; and the second or Internal Respiration in the tissues

between the cells and the blood where the exchange of gases is in the reverse direction.

The Organs of Respiration are the lungs, and the passages leading to them (nose, larynx, trachea and bronchial tubes) and in addition to the entire vascular system (circulatory system).

The Lungs. In order to be able to understand what happens to the air taken into the lungs, it is essential to have some knowledge of their structure.

The lungs are the real organs of respiration. They are two in number, lying one on either side in the chest cavity.

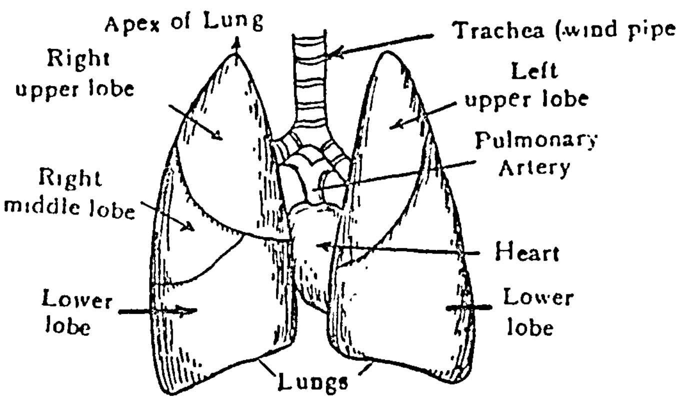


Fig. 32.—Organs in the chest cavity.

The lungs are large conical bodies. In young people they are pinkish in colour, and as age advances, they become greyish, and finally in old age, they become dark.

The lungs are covered with a membrane called the Pleura which also lines the inner surface of the ribs.

The space between the two lungs is called the Pleural Cavity. In the disease called pleurisy fluid exudes into this cavity.

The lungs are filled with air and are so light that they will float in water.

The right lung is divided into three lobes and the left into two. These lobes are further sub-divided into smaller lobes or labules and these consist of air cells or alveoli.

The lungs then are composed of air sacs or alveoli and these are arranged together like bunches of grapes.

Fig. 33.—A small piece of lung (highly magnified).

These groups of air sacs are about $\frac{1}{40}$th part of an inch in diameter. Each cell has minute blood vessels running through its walls which contain impure blood brought from the various parts of the body.

We breathe 16 or 17 times per minute, and at each breath, the cells become filled with pure air.

The minute blood vessels in the cell walls are constantly taking in the oxygen contained in the inspired air and discharging impurities in the form of carbonic gas, watery vapour and other waste matters.

The Trachea (windpipe) is five inches long and is situated in front of the oesophagus (foodpipe). It is connected with the lungs by two Bronchi.

It runs down the neck, and on reaching the chest, it divides into the right and left bronchi which enter the lungs.

Each bronchus divides and re-divides into finer and finer branches until finally each branch opens into a bunch of alveoli.

The Trachea is made up of 16 to 20 incomplete rings of cartilage. Due to these rings, the windpipe is always kept open even during sleep and thus continuous breathing goes on without any obstruction.

The Larynx (Voice box) :

The trachea opens into the throat by means of the larynx. The larynx lies in the front and the upper part of the neck being placed below the tongue and between the large vessels of the neck. It opens above into the pharynx and below into the trachea.

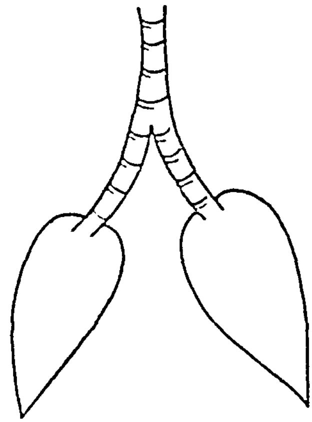


Fig. 34.—The branching of the windpipe into the lung.

The air passing through the nose gets to the pharynx. From there it goes to the larynx. The opening into the larynx is guarded by a little flap or lid which lies behind the root of the tongue and folds down over the trachea when food is swallowed.

This prevents the food from entering the windpipe. The flap is called the Epiglottis.

The larynx is composed of cartilages united by ligaments and moved by muscles. The largest cartilage is in front and can be seen and felt in the neck as a prominence. This is popularly known as 'Adam's Apple.'

The larynx though it acts as an air passage, yet is properly an organ of voice.

There are two thick cords of elastic tissue lying across its interior—these are called the Vocal Cords.

The vocal cords open wide apart during the process of breathing in air and come close together when high notes are uttered.

Voice is the sound uttered by the mouth and is produced by the vibration of the vocal cords. The enunciation

of distinct words (articulation) is produced by the proper use of the lips, tongue and palate.

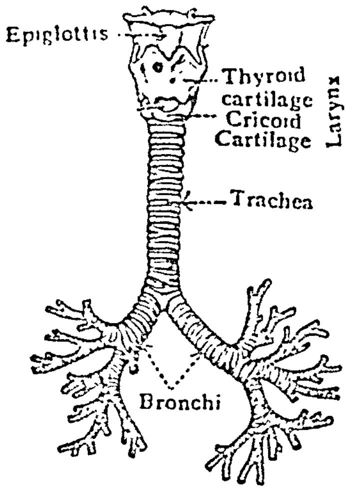


Fig. 35.—The Larynx, Trachea and Bronchi.

Fig. 36.—The Human Larynx. I, when speaking ; II, at rest.

Nose. The right entrance for the air in ordinary breathing is the nostrils. Air drawn in through the nostrils has to pass through a filter of small hair situated at the entrance of the nose. Then it passes through twisted passages made by little, thin, curled scroll-like bones which are covered by mucous membrane. This membrane is supplied with blood vessels and the air in passing over them is warmed, moistened and cleaned.

The mucous membrane manufactures a sticky, viscid substance which catches small particles, such as dust and germs. Very few microbes (germs) can get past the large surface that has to be passed over by air taken in through the nose, and the germs that are caught there are often killed. Thus nose-breathing is the chief safeguard against colds and a number of other infections.

If the air goes through the mouth straight to the trachea, it goes too quickly, and reaches the lungs only partially filtered and warmed and moistened. It is, therefore, necessary to keep the nose clean.

In the throat and pharynx there are small masses of lymphoid tissue called tonsils. If the air which strikes on them is cold and dry - they become overgrown and nose breathing becomes difficult.

Children who suffer from the enlargement of these glands get into the habit of breathing through the mouth, and consequently, many germs that would ordinarily be caught in the nostrils get into their lungs and they often suffer from colds.

The Process and Purpose of Respiration. The purpose of respiration is to purify the impure blood by freeing it from carbon-dioxide and to satisfy the body's demand for oxygen.

Oxygen is not a food but it is the nature's key which liberates energy; for the foodstuffs are really stores of chemical energy, and before this energy can be set free for the uses of the animal body, they must be oxidised or burnt.

Respiration. The combined movements of inspiration and expiration constitute what is known as respiration or breathing.

The action of drawing air into the lungs is called inspiration, and the action of driving the air out of the lungs is called expiration.

The next question to consider is: what makes the air go into and out of the lungs?

The lungs are suspended inside an air-tight box, the chest, in such a way that no air can get between the lungs'

and the chest wall and the only way air can get in is by the lungs. So if the cavity inside which the lungs are situated enlarges, the lungs must follow the movement and enlarge too ; and if it contracts, they must contract.

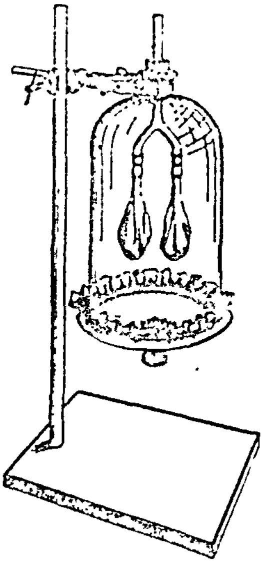


Fig. 37.—Apparatus to illustrate change of size of elastic lungs with change in size of chest cavity. The rubber membrane at the bottom represents the diaphragm, when this is pulled down, the balloons enlarge and air is drawn in ; when it is pushed up, the balloons collapse and air rushes out.

This is made possible by the elasticity of the lungs. The chest is bounded in the front, back and sides by the ribs, spine, and sternum and the muscles attached to these bones, and at the bottom by a stout sheet of muscle the diaphragm. Besides the diaphragm and the intercostals, the other muscles concerned in respiration are those of the neck, chest and belly.

Inspiration. During inspiration the ribs are lifted, and, as at rest they slope downwards, this increases the distance between the spine and the sternum. At the same time the ribs turn outwards and so increase the lateral (side to side)

diameter. This happens as a result of the contraction of the intercostal muscles. The vertical diameter is increased by the

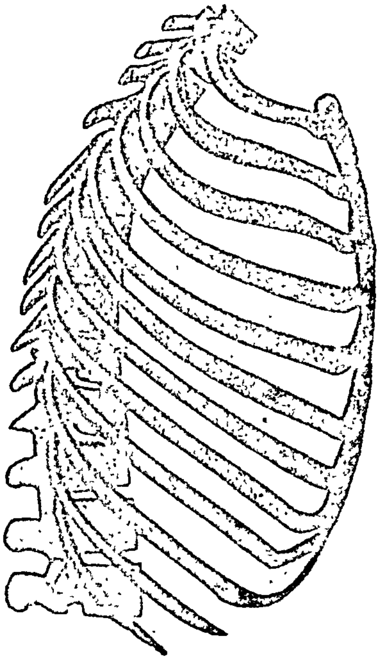


Fig. 38.—Right half of the Bony Frame work of the Chest (After Spalteholz).

contraction and lowering of the diaphragm. Thus the chest cavity is enlarged all round. The lungs being elastic, expand with the enlargement of the chest cavity ; as a result of which, the air pressure within the lungs is diminished. To equalise the pressure within the lungs, the air from outside rushes in.

Expiration. When the lungs have taken as much air as they can contain, a short pause follows. Immediately a reverse movement follows which diminishes the chest cavity and thus forces the air out of the lungs. This is called Expiration.

The diminution of the chest cavity is brought about in the following two ways :—

(*i*) The diaphragm relaxes and is raised up.

(*ii*) Another set of intercostal muscles pulls the ribs and the sternum down.

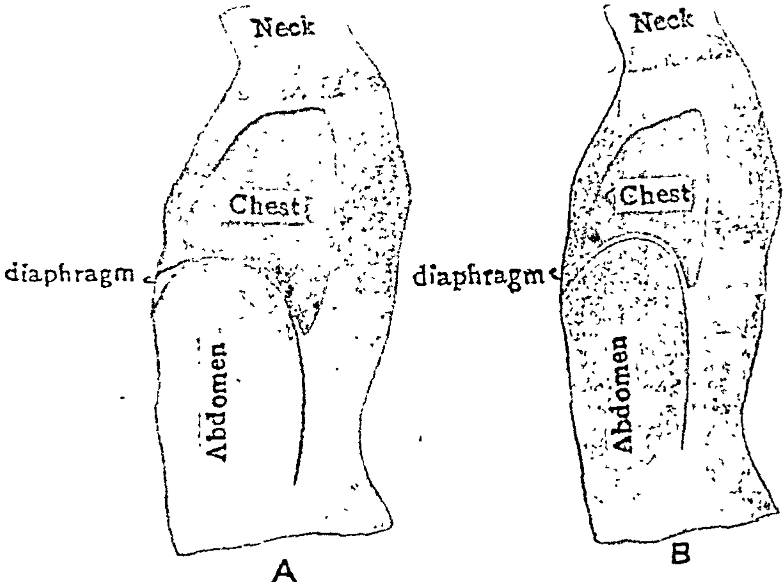


Fig. 39.—Diagram of the changes in the size of the Chest during breathing
A.—After inspiration. B.—After expiration.

This is the method by which the air in the lungs is constantly renewed.

We draw our breath 16 or 18 times every minute when we are sitting quietly but the rate is increased when we are taking exercise or when we are suffering from fever, mental excitement or some lung disease.

In infants and children it is always quicker than in adults. The respiration rate is less than normal in sleep, concentration and opium poisoning.

When as much air as possible is forced out of the lungs, that which still remains in them is called Residual Air.

The air which is left in the lungs after an ordinary expiration is called Supplemental Air. The air comprehended under these names does not leave the lungs and is called "Stationary Air." (Huxley)

During repeated acts of respiration, the so-called "stationary air" is changed by other air and it is only to the air that remains in the lungs at any given moment that the term 'stationary' is applied.

In very deep breathing in which the collar bones are raised as much as possible, the largest quantity of air is taken into the lungs. This is known as the Vital Capacity of the lungs.

Difference between Inspired and Expired Air. The air that is breathed out is foul and is different in composition to the air that is breathed in. The amount of oxygen is reduced ; carbon-dioxide, water vapour, organic impurities and temperature get increased in the expired air.

The following table gives the percentage analysis of the two by volume : –

	Inspired Air.	Expired Air.
Oxygen	20 96	16·40
Nitrogen	79·00	79·00
Carbon-dioxide ...	0·04	About 4·10
Organic Impurities ..	Nil	Traces
Water Vapour ...	Dry or moist	Moist
Temperature ...	variable	Body temperature 98·4F

Artificial Respiration. Sometimes it is necessary to carry out artificial respiration on people who have fallen into the water or who have been poisoned by carbon-monoxide from sleeping in closed rooms containing a live 'Sigri or Angithi'. These people have stopped breathing and air has to be got in and out of their lungs by some other method.

Schafer Method of Artificial Respiration. The patient is put in the lying position with the head turned sideways to leave the mouth free and a rug placed under the chest. The operator then kneels astride the patient and places his hands on the back below the shoulder blades, with fingers outwards and palms towards one another near the middle of the back. He should then lean forward slowly bringing his weight on to his hands (not violently). This compresses the chest and a great volume of air is forced out. The

operator then straightens his body and takes its weight off his hands. Now, owing to the elasticity of the chest walls of the patient, the cavity is enlarged and air is drawn in. This process is repeated about 16 – 20 times a minute. Sometimes natural breathing begins after about two hours of artificial respiration.

This method of artificial respiration is fairly satisfactory, for it does not need any apparatus. Knowledge of this method will be very useful in an emergency.

CHAPTER VIII

THE EXCRETORY SYSTEM

Every engine produces some waste products during the period of combustion—ash, smoke, soot. The human body is an engine which is no exception to the rule.

We have followed the process of digestion when the combustible foodstuff is reduced to a useful state ; and the process of absorption of air from the lungs and its entrance into the blood. We have also followed the distribution of food and air by the circulation of blood to the various parts of the body and its utilisation then by the tissues.

During life some cells are breaking up to produce heat and energy (katabolism) ; and new cells are being formed to replace the old worn-out ones (anabolism). These two processes (anabolism and katabolism) constitute Metabolism.

This includes all the changes which the absorbed food undergoes after absorption and before excretion.

Metabolism is indeed a kind of combustion or burning, and certain waste products result. The most constant of these is water. The next most constantly formed waste product is carbon-dioxide. Then the non-digestible residue of food must be got rid of.

In the breaking down of the tissues and in the utilisation of the protein matter, nitrogenous waste products such as urea, uric acid and others are formed. All these waste substances must be thrown out of the body, first because they are useless, second because in some cases they are poisonous, third because they are in the way.

Excretion therefore means the removal from the blood of water, carbonic acid gas, urea and other waste products, which are formed during the performance of the various functions of the body. Various parts of the body share in the functions of excretion, each doing its part.

The large intestine excretes in the stools the last waste products of digestion ; the lungs excrete water and carbonic acid gas. The skin excretes in the form of perspiration, water and some salts, and a few nitrogenous bodies. The chief excretory passage of the waste products of proteins and tissue waste is by way of the kidneys.

The Large Intestine. While we are discussing the process of getting rid of waste products from the body a word should be said about the lower part of the large intestine.

Many of the foodstuffs we eat contain some waste matters which are useless to the body. For example vegetables and fruits contain a large proportion of cellulose which the digestive juices cannot dissolve. Yet it serves a useful purpose, because it excites movements of the walls of the digestive canal, and this drives the waste products slowly along the food canal until they leave the body in the form of stools, fæces or excreta.

Bacteria form a large part of the stools ; even up to half the weight of fæces (stools) may be formed of bacteria. In addition, the stools contain worn-out cells from the lining of the intestines, unwanted ingredients from the food and materials from the digestive juices.

This mass collects in the rectum and the emptying of the bowels in an act of excretion, which should be performed daily. If these products accumulate, as happens in constipation, it may be the cause of much ill-health.

The lungs help in the removal of the water that the body does not want. They also provide the path by which excess of carbon-dioxide is sent out from the blood.

The Skin. From the surface the skin appears to be quite a simple structure but this is not really so. If you examine a piece of skin under the microscope you will find that the skin consists of two layers. The top or the outer layer is called the Epidermis (cuticle). This layer consists of many rows of cells of which the top ones are flat. These flat cells form the horny layer of the epidermis.

As the surface of the skin is continually being rubbed, these flat cells get worn off and are replaced by growing cells from the layers below.

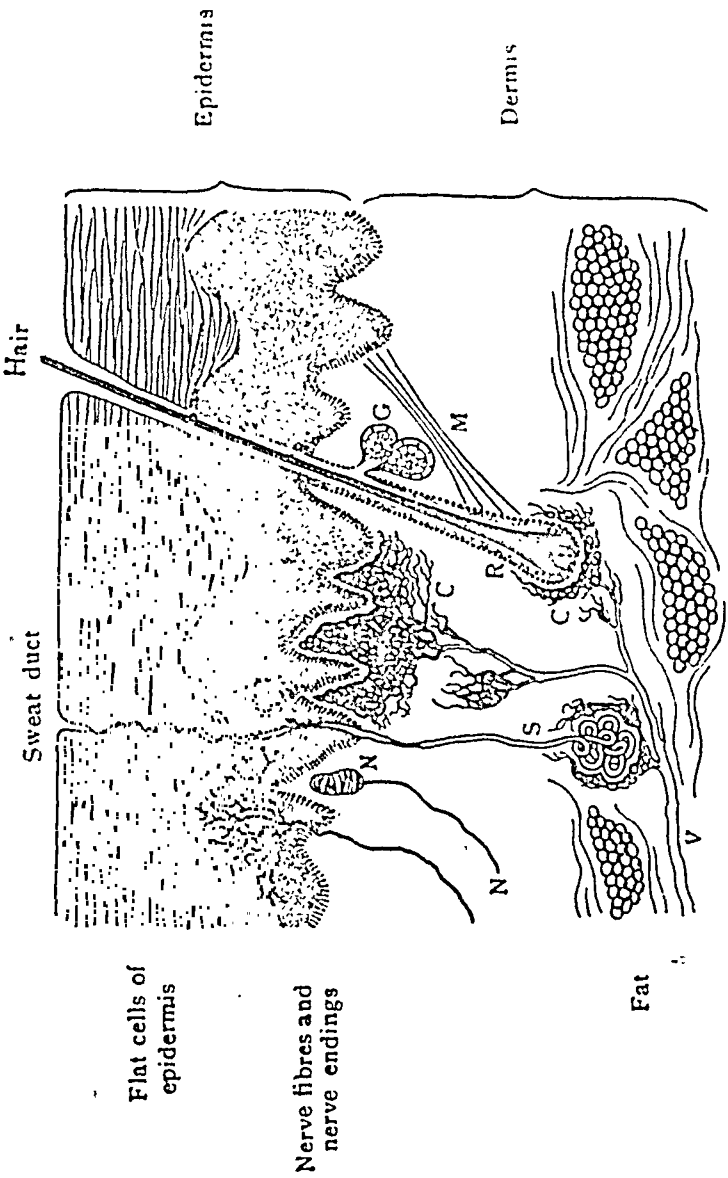


Fig. 40.—Section through the Skin, highly magnified.
C=blood capillaries N=nerve fibres and nerve endings
F=fat G=oil gland R=hair-follicle S=sweat-gland H=hair
T=sweat duct V=large blood-vessel

The deepest layer of the epidermis called the Malpighian layer contains the colouring matter (pigment). The pigment is responsible for the differences in colour of different races of mankind.

Congenital absence of colour is known as Albinism and excess of colour is called Negrism.

Blood vessels are absent from the epidermis, which is specially thick at the palms and soles.

The second layer of the skin called the Dermis (cutis or true skin) is thick and tough. It is from this layer of the hides of animals that leather is made. When the epidermis is rubbed off the dermis bleeds freely.

Imbedded in the dermis are sweat glands. The ducts of the sweat glands have openings all over the body. There may be two or three millions of them.

In the dermis are also the hair follicles from which the hairs grow out through the epidermis.

Opening into the follicles are oil glands (sebaceous glands) which manufacture an oily substance which keeps the skin, and hair soft and pliable. Fine muscle fibres are attached to the hairs and in animals possessing fur these fibres contract and make the hairs stand on end.

The dermis contains fine blood vessels and nerves. In the lower part of the dermis there is fat which varies in amount in the different parts of the body and in different people.

Functions of the Skin. It is true that the skin is an organ of excretion and that waste substances leave the body both in the sweat and in the oily matter from the oil glands but the skin has other functions which are very important.

The sebum from the subaceous glands helps to keep the hairs in sound condition. It also provides a waterproof coating for the epidermis.

The skin is responsible for regulating the temperature of the body. The heat generated in the active tissues of the body when they burn the foodstuff supplied to them warms the blood and unless heat were got rid of at a rate nearly equal to its rate of production the body temperature would rise.

The normal temperature of the human body is round about 98·4° F., and any marked change from the normal temperature would upset the normal activities of the system. It is therefore necessary if we are to maintain a constant temperature that there should be proper adjustment of heat loss to heat production and that the two processes should be balanced.

In cold weather we take more food and so furnish more fuel. We are also more energetic in cold weather and so burn more but the heat production and heat loss are balanced.

If the quantity of blood that flushes the skin blood vessels varies, the amount of heat loss correspondingly varies. When the organs are active the heat production is increased. When it is warmer (summer) and it is less easy for heat loss to occur quickly, the small skin vessels get larger, more blood passes through them and more heat can be lost.

Another and a different way in which the skin makes it possible for the body to regulate loss of heat is by the evaporation of water from the surface of the skin. Evaporation of water cools the body, because you need heat to change a liquid into vapour and in the case of the body this heat is got from the warm skin.

When the heat production is suddenly increased (as for example when you take exercise) and when the temperature of air is raised, the loss of heat must be increased.

The body is constantly giving out some water from the skin This is called Insensible Perspiration. When the heat loss is increased the sweat glands become active and sweat is given out rapidly in the form of liquid drops. This is called Sensible Perspiration.

As a rule, two pints of water a day is lost by the body as sweat, but the quantity may be increased five times, if the day is warm and if you take some exercise.

The loss of heat from the skin should be constantly going on steadily and slowly. Anything which causes a too rapid increase in the rate produces a sense of chill.

On the other hand anything which reduces the heat loss to a large extent may give a sense of stuffiness and discomfort.

Perspiration (sweat). It consists chiefly of water which contains some salts and oil.

Normally it is acidic in reaction. When alkaline it smells unpleasantly. We must keep our skins clean, for otherwise, the pores become blocked up, the sweat cannot go out and the health suffers.

Sudden cooling of the body, after hard exercise or exposure to heat, is very risky. It often causes colds, and, owing to the blood being suddenly driven from the skin, inflammation of the lungs, kidney, liver, and other organs often results. Chills, too, often are the causes of diarrhœa.

Another important function of the skin is that of protection. The epidermis protects the body in different ways. It protects the delicate structures beneath from injury by hot or sharp things. The outer layer of the skin may be injured but in a healthy person this part recovers easily. The outer layers of the skin also stop the entrance of germs, which can only enter if the skin is damaged.

In human beings the hairs act as sense organs and give one information about the objects just going to touch the skin.

The Kidneys. The kidneys are two in number. They lie one on each side of the backbone and they are covered with a special layer of fat of their own. The kidneys have thus been placed in a very safe position ; for so important are they that damage to them must be avoided at all costs.

The kidneys are dark brown in colour. The convex surface of each kidney is turned outwards. On the concave side of the kidney is a deep pit called the Hilum.

Running from the hilum of each kidney is a tube, (ureter), which passes down into the lower part of the body where it opens into a thin walled bag (Bladder).

The bladder is situated at the foot of the abdomen and acts as a reservoir for the waste products and collects them for a time. The lower end of the bladder opens by another tube (Urethra) to the exterior.

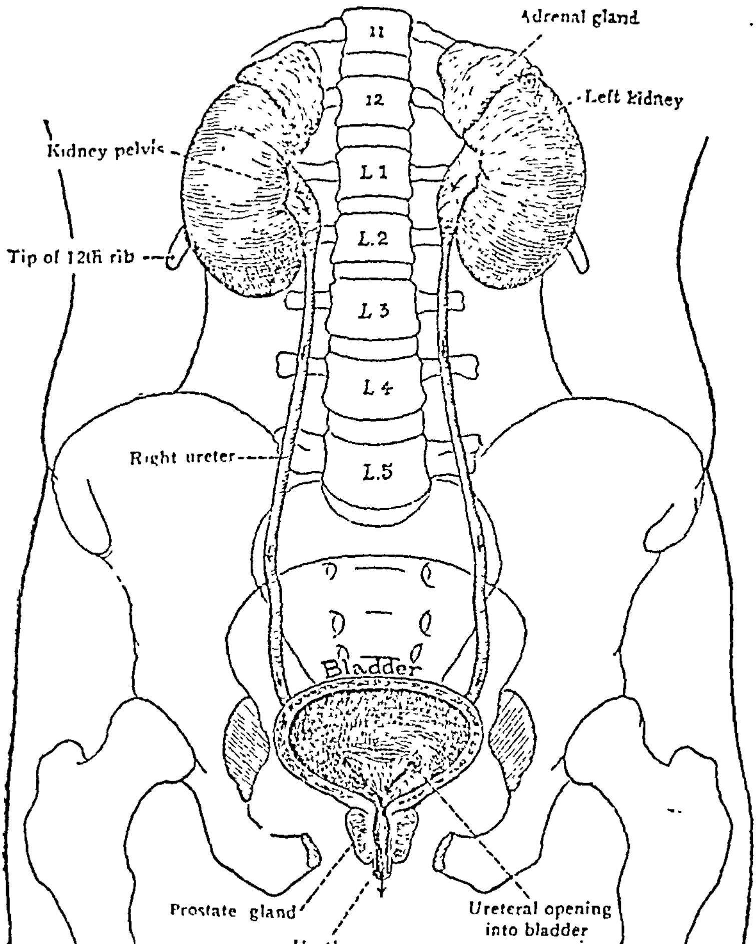


Fig. 41.—The urinary system—kidneys, ureters and bladder. The adernal bodies are shown on top of the kidneys.

The urine made by each kidney passes along the ureter to the bladder where it collects and gradually fills

the bladder and stretches it. The neck of the bladder normally remains closed by several rings of muscles.

The kidney is one of the most wonderfully constructed organs in the body. If a kidney is cut open you will see that it has an outer portion called the Cortex and an inner portion called the Medulla.

At the point of entrance into the kidney the ureter dilates into a funnel-shaped cavity, known as the Pelvis of the Kidney.

The pelvis is thrown into projections known as the Calyces. There are ten to twelve conical structures arranged round the pelvis ; these are called the Pyramids. Each pyramid contains a large number of fine tubes known as the uriniferous tubules. The tubules are dilated towards the cortex and these dilatations are known as the Malpighian Capsules.

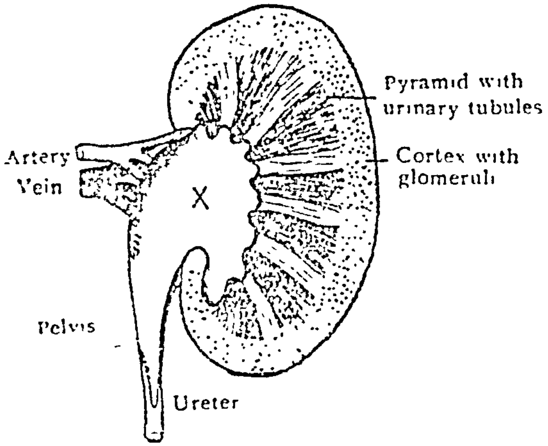


Fig. 42.—The kidney split open to show the structure.

The kidneys are supplied with renal arteries which divide repeatedly into as many branches as there are pyramids. Each branch then enters a pyramid and further divides into as many branches as there are uriniferous tubules. The branches of the renal arteries then run along the tubules and enter the Malpighian Capsules, where they further sub-divide and form networks of capillaries called the Glomeruli. The blood flowing into the glomeruli gives out

its waste products of which the urine is composed. The Malpighian bodies are thus filled with urine; from there it is constantly carried by the tubules to the pelvis. The urine then passes through the ureters to the bladder. It gets collected in the bladder and is thrown out every few hours through the urethra.

After profuse perspiration in very hot weather or during hard exercise, it is wiser to satisfy slowly the thirst caused by the great loss of water, so that the replacement is gradual and no sudden change in blood volume and blood composition occurs to disturb the functions of the system.

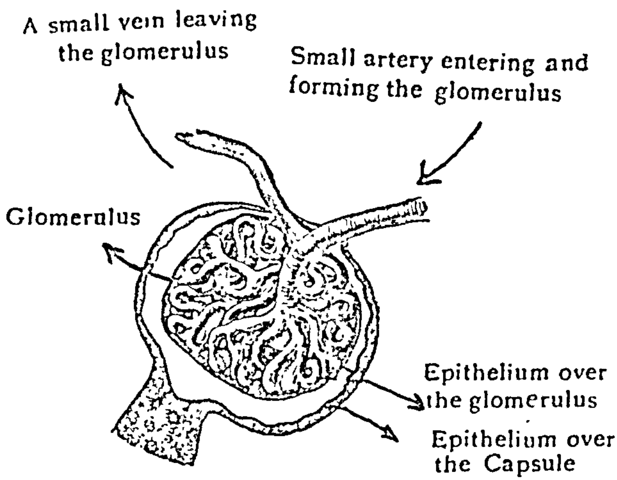


Fig. 43.—Malpighian Capsule.

Ordinarily 40 to 60 ounces of urine are excreted in the twenty-four hours. The water you drink plus the water contained in the solid food and made during metabolism, ought to balance the daily loss.

A number of people probably do not take enough water. It is not harmful to drink plenty of water as the kidneys will get rid of excess. One should avoid kidney troubles. Some of the simpler causes can be avoided, such as exposure to cold, the habit of over-eating, which gives the kidneys too much work to do in getting rid of waste matters, and alcoholism Plenty of exercise should be taken during cold weather particularly, to keep the skin active and thus avoid giving too much work to the kidneys.

The urine is a yellowish liquid consisting chiefly of water and urea. It also contains some common salt and other mineral substances such as lime and magnesia and some gases chiefly carbonic acid gas. The intensity of its colour varies with the amount of water in the urine.

After exercise when a lot of water has been got rid of by the skin, less urine is passed and it is deep yellow On the other hand if one drinks plenty of water more urine is formed and the liquid is pale yellowish in colour.

Urine like sweat is a liquid containing excreted substances in solution, so that whether or not there is excess of water in the body that most important material is continually being removed.

It is possible to live for many weeks without food, but if a person is unable to get liquid to drink, death occurs in a few days. Fasting people therefore must always drink water or some other fluid containing water.

CHAPTER IX

THE NERVOUS SYSTEM

One of the most striking characteristics of human beings is that each one is a 'person.' The body performs a number of functions, such as walking, talking, etc., and these actions are controlled by a marvellous set of cells; and it is their duty to control certain actions of the body and to carry messages from one part of the body to another.

If somebody pricks your finger with a sharp needle, you at once draw your hand away from the source of danger.

What actually happens? As soon as you pricked the skin of the finger, a message went from the skin to the brain telling it that the finger had been hurt, and a message immediately comes back from the brain to the muscles of the arm telling them to draw the finger away from the source of trouble.

It all happens very quickly but it involves a complicated machinery made up of innumerable cells which can be divided into parts.

(1) The nerves which run to the outside parts of the body, and (2) the Central Nervous System which is where the main control lies.

The entire nervous system resembles a telephone exchange in which the skin, the eyes, the ears and so on, represent one lot of telephones from which there run back to the central exchange a very large number of tiny wires. Running away from the exchange are another set of wires which go to telephones in the muscles, and certain other organs. The messages are transmitted very quickly and the answer in most cases is immediate.

The human body may be compared to a steam engine. The engine is controlled by a driver but the human body has its own driver — the nervous system.

It is the nervous system which is responsible for directing, controlling and coordinating their activities for the common good of the entire body.

Without the nervous system, we would be senseless, sightless, soundless and motionless masses of the living substance (Protoplasm).

The central nervous system gives us every contact which we ever possess with the rest of the world. It answers to these contacts in terms of agreement or repluse. In some peculiar way it provides us with every association, every pain, and every delight which we experience throughout our life.

The Nerves. These are the telephone wires of the body and they carry messages from one part to another.

We have two sets of nerves :—

( ) The Motor nerves, carrying messages from the brain or the spinal cord to the muscles, blood vessels, glands, etc. These are also called the Efferent nerves.

(ii) The Sensory nerves (Afferent) carry impulses from the sensitive parts of the body to the brain or the spinal c rd. Some nerves are purely sensory while

others purely motor, but the majority of them are mixed nerves.

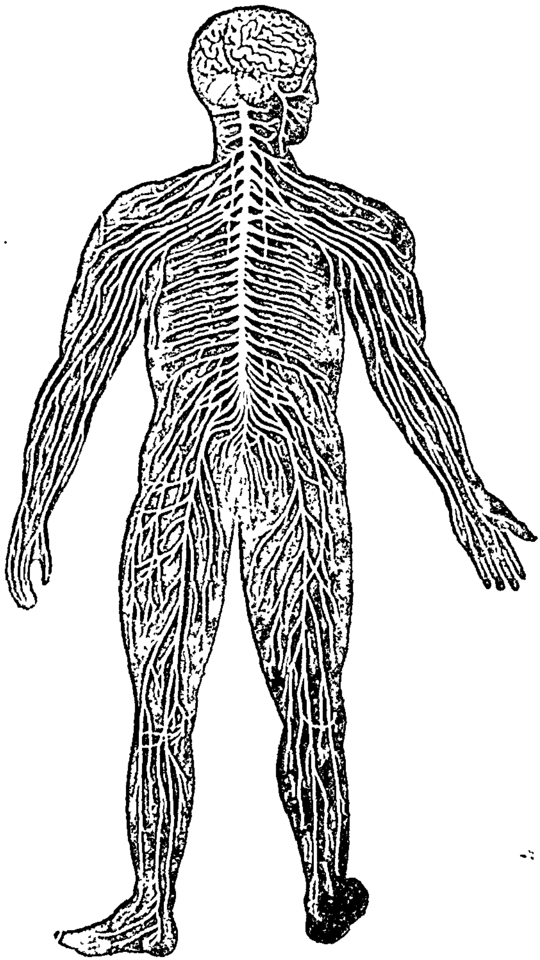


Fig. 44.—The nerves going from the brain to all parts of the body.

The Central Nervous System. It is a very important system, and consequently, it is well protected by being packed away inside the skull and the backbone.

It is still further protected by three delicate but tough membranes which are found between it and the bones and by a kind of fluid found in this space which acts as a kind of water cushion protecting it from sudden shocks.

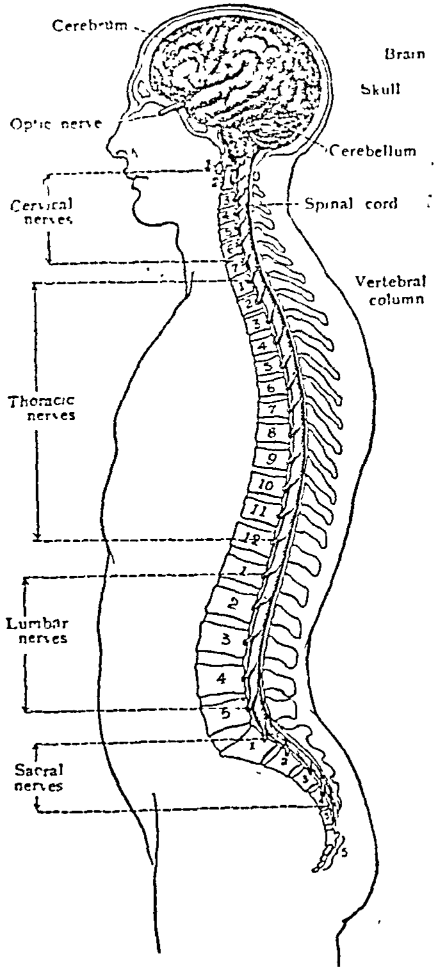


Fig. 45.—General view of the central nervous system.

The central nervous system consists of the brain and the spinal cord.

The brain. It is a soft pinkish white mass of nerve fibres and nerve cells. It lies protected in the skull. On an average it is about fifty ounces in weight. The greater portion of the brain consists of the cerebrum (great brain) which occupies the entire upper region of the cranium. The cerebrum is made up of two cerebral hemispheres which are joined together in the median line by a transverse band of nervous matter.

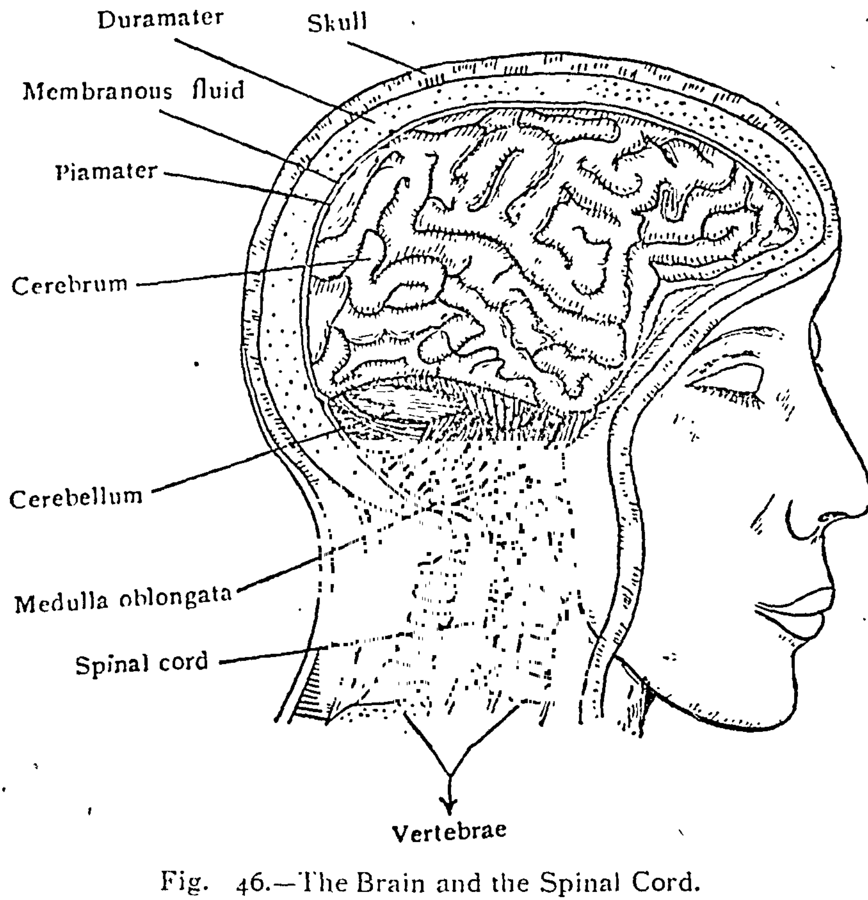


Fig. 46.—The Brain and the Spinal Cord.

The brain on the outside consists of grey matter—the Cortex. The interior of the brain consists of white matter.

The cerebrum is associated with the intellectual processes of memory, reasoning and so on. It is the supreme adjuster of all our actions.

Lying behind and almost hidden by the cerebrum is the small brain or cerebellum. Situated on the under surface of the cerebellum is a rounded body known as the Pituitary body. This is an important structure, for it controls the general growth of the body.

The cerebellum helps the body to maintain its balance and poise.

Joining the brain to the spinal cord is a cylindrical mass of nervous matter, about an inch and a half long. This is known as the Medulla oblongata.

The composition of the medulla oblongata is different from that of the rest of the brain. Here the white matter is on the outside and the grey matter within.

The medulla oblongata contains important centres which control functions necessary for life : breathing, circulation of blood, swallowing and a large number of other essential activities.

The Cranial Nerves. From the brain originate twelve pairs of nerves—the Cranial or the Cerebral nerves.

The first pair are the Olfactory nerves. They are the oldest parts of the brain, and as the name suggests, they are connected with the sense of smell. These nerves spread out on the inner surface of the nose. They are sensory in nature.

The second pair are the Optic nerves, which carry the impulses from the eye which give rise to sensations of sight. They are sensory in nature.

The third, fourth and sixth pairs of Cranial nerves are purely motor and supply the various muscles of the eyeballs.

The fifth pair are mixed (both motor and sensory). This nerve divides into three branches. One branch is sensory and goes to the eyeball, mouth, teeth, nose and cheeks. It ends in the tongue where it spreads out over its front surface. This is responsible for the sense of taste. The other two are motor and go to the jaw muscles.

The seventh pair are motor and go to and control the muscles of the face. mouth & lips

The eighth pair are associated with the hearing and also with balance. They are sensory and go to the ears.

The ninth pair are mixed. This nerve divides into two branches. One branch is sensory and goes to the back part of the tongue taste). The other branch is motor and goes to the muscles of the pharynx (act of swallowing).

The tenth pair called the Vagus are mixed. They spread very widely over the body, carrying messages to and from the brain and many organs, such as the heart, lungs and the digestive organs.

The eleventh pair are motor and go to the neck and back muscles.

The twelfth pair are also motor and go to the muscles of the tongue.

The cerebrum becomes larger as the intelligence of animals increases. The monkey has a much bigger cerebrum

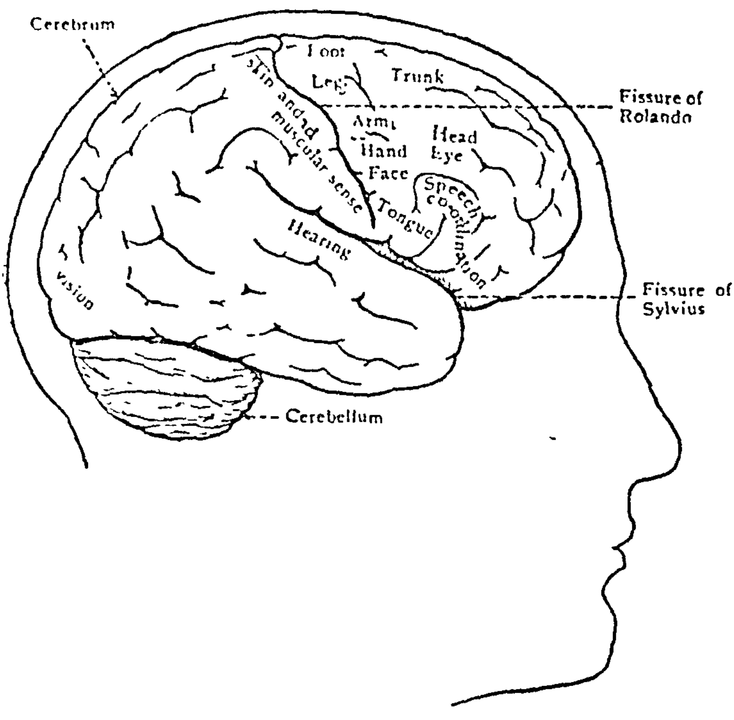


Fig. 47.—Localization of function in the brain.

than the rabbit, man a much bigger one than the higher apes.

Certain parts of the brain are associated with special jobs and these functions vanish if the parts of the brain associated with them are destroyed by disease or accident.

The hand has a much bigger part of the cerebrum associated with its movements than the whole of the trunk muscles and the part controlling the throat muscles used in speaking is relatively large.

When we realise the great advantage the power of speech gives us over all other animals, it is not surprising that it has considerable representation in the brain.

The right hand is controlled by the left side of the brain, and vice versa. Sometimes training left-handed people to be right-handed makes them stammer. If it does, it would be wise to give up the attempt.

It is indeed not the weight of the brain so much as the extent of its surface that is responsible for quality and capacity. To give increased surface the human brain is greatly folded or convoluted.

Thus the surface can be greatly increased without unduly increasing the bulk.

Learning depends upon making connections between different parts of the brain by developing what are called association tracts.

The brain has a very big capacity for laying down associations and this is not surprising when we realise how many cells there are in the cortex.

Live and learn is an old saying and all our lives we are of course learning to a certain extent.

It is a good thing to keep the brain exercised. Never let the brain get out of the habit of doing a certain amount of intellectual work, so as to keep it always fit. This is perhaps particularly necessary on leaving school when it may be difficult to keep up the habit without the usual school discipline. The intellectual qualities get rusty if they are not used. The important thing is to keep up the habit of learning.

The Spinal Cord. In continuation of the medulla oblongata is a thick nervous cord—the spinal cord, which is located in the vertebral canal. It is about 18 inches in length and about half an inch thick tapering into a filament about the level of the second lumbar vertebra. (See Fig. 45).

Thirty-two pairs of Spinal Nerves arise from the Spinal cord and get out of the vertebral column through the intervertebral spaces. They go to the skin, motor mechanism, and parts of the viscera. All these are mixed nerves.

Each nerve of the pair is made up of two parts ; one from the front of the cord called the Anterior root, and the other from the back—the Posterior root. The anterior root fibres have their origin in cells in the front part of the grey matter of the spinal cord ; the posterior are the fibres of some nerve cells found on the posterior root ganglion (a mass of cells and fibres found on the posterior root close to its junction with the cord).

The anterior root carries impulses out of the cord and therefore its fibres are efferent (motor) ; the posterior root carries impulses into the cord, thus its fibres are afferent (sensory).

In any organization there has to be a certain amount of divison of labour if the work is to be done quickly and well. In a big retail shop, for example, there would be a good deal of delay if every order had to go to the head office, before it could be carried out. The same type of division of labour is essential for the central nervous system.

The cortex of the brain is the final authority. Controlled by it, but capable of, if need be, of acting independently of it, are nerve centres at various levels which have plenty of independence. Actions which are performed through such centres, independent of the will, and often without consciousness, are called Reflex Actions.

If the foot of a sleeping person is gently tickled, so that he does not wake, the foot will be withdrawn. In this case consciousness is not brought into play because the

different impulses coming in by the spinal cord do not get up to the brain, and such actions which take place through centres in the spinal cord are of the kind called Reflex Actions.

Generally speaking, reflex actions have a protective effect; and the fact that they are more or less spontaneous without troubling the brain for the necessary instructions, is certainly a great advantage to the individual. This protective effect is shown in many examples of reflex action; the withdrawal of a limb from a prick or a burn; the closing of the eyelids if a foreign body comes near the eye; the secretion of saliva at the mere thought of palatable foods.

In reflex actions sensory impulses travel through the fibres of the spinal nerves, and by way of its sensory root, reach the grey matter of spinal cord.

These impulses act upon the grey matter in such a way as to cause new impulses to travel along the motor nerve fibres to the muscles concerned

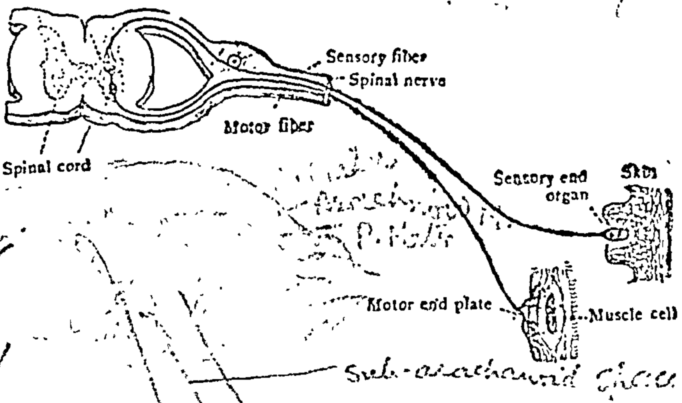


Fig. 48.—The reflex arc in the spinal cord.

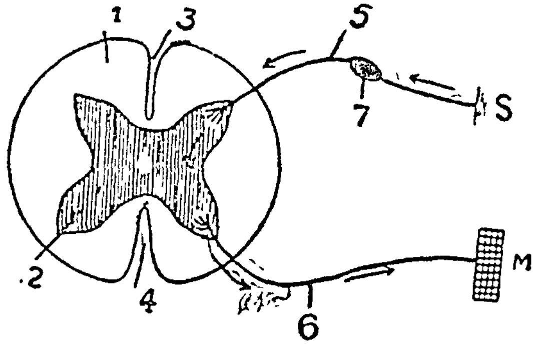


Fig. 49.—The reflex arc in the spinal cord.

1. White matter.
2. Grey matter.
3. Front groove.
4. Back groove.
5. Sensory root.
6. Motor root.
7. Ganglion.

S. Stimulus applied. M. Muscle affected. The arrows show the paths taken by the stimulus and the response.

Sympathetic Nervous System. Lying on each side of the front of the vertebral column, there is a thin long nerve called the Sympathetic Cord. At intervals on this cord occur small enlargements of nervous tissue known as the Sympathetic Ganglia. These are joined on to the spinal nerves and thus the connection between the sympathetic and the central nervous system is established.

From the sympathetic cord a large number of fibres are given off to various internal organs, such as the heart, lungs, stomach, intestines, bladder and blood-vessels.

The sympathetic nerves carry impulses which govern the action of the muscular tissues of the various internal organs and of the muscular coats of the small arteries. The tone of the blood-vessels is kept up by the sympathetic system which also exercises a general control over the working of the various internal organs such as the heart, lungs, stomach, etc. No impulses originate in the sympathetic system but it distributes the impulses derived from the central nervous system.

CHAPTER X.

Special Senses.

Human beings possess wonderful powers of adaptations. They can live in warm countries, or in cold places, in villages or towns, in dry or damp climates and they can protect themselves against sudden emergencies.

To be able to do this, it is necessary that the body must be kept correctly informed of changes in its surroundings. This essential information regarding the outside world is obtained by means of the organs of special sense. They are as follows :—

(1) the eyes for vision ;
(2) the ears for hearing and balance ;
(3) the nose and mouth for smell and taste: and
(4) the skin for touch, temperature and pain.

Without these we would be nowhere. But if only one sense, such as, the sense of hearing is absent, it is possible to a great extent to compensate for this by an intensive training of the others.

The senses have different degrees of importance at different ages. In the very young, sight is poorly developed and learning mostly depends upon hearing : later on this is reversed and most of our information reaches us through the eyes.

The Eye. The eye is the organ of sight. It is protected from injury by being placed in a socket in the skull and by being fitted with eyelids.

The upper eyelid only is movable and it shuts down if anything dangerous is seen coming near the eye. The eyelids also protect the eye against the entry of dust particles when the eyes are closed.

Connected with the lashes are glands which give out an oily secretion which prevents both the eyelids and the lashes

from sticking together. When one of these glands is blocked, you get the painful stye.

The constant secretion from the Lachrymal gland (tear gland) keeps the eye moist. The secretion is normally small in amount and it passes out through the two small openings which open into the nose cavity. When this secretion is formed more quickly than it can be drained away, there is an overflow known as tears.

The eye is made up of three coats. The outer one is protective and its opaque part forms the Sclerotic (the white of the eye), but in front where it becomes the Cornea, it is transparent to allow the rays of light to pass through.

The middle coat or the choroid is abundantly supplied with blood-vessels and plenty of muscle fibres in some of its parts. The choroid is not complete in front, the gap forming the pupil.

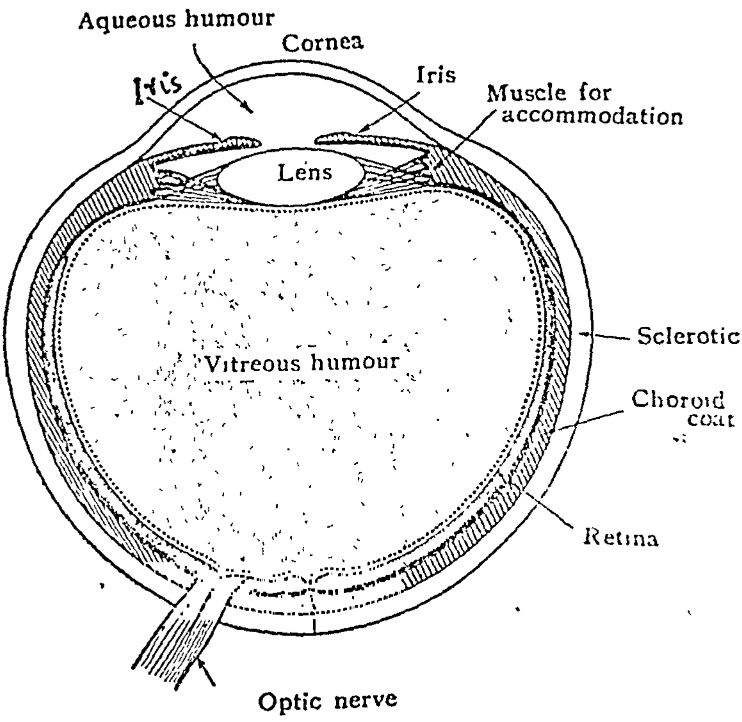


Fig. 50.—Section through the eyeball.

The size of the pupil can be altered by the actions of the muscles of the Iris (the coloured portion of the choroid).

The inner coat is called the Retina. This part of the eye is sensitive to light and it fits closely to the others.

It has, on its outside, some specialised cells—the Rods and Cones that are so stimulated when light is focussed on them that they pass on messages to other nerve cells in the retina. These are continuous with the optic nerve, which ultimately carries the impulses to the hinder part of the brain where visual sensations are appreciated.

Close behind the iris is the lens which, together with the cornea, focusses the light rays coming from an object and makes a clear picture of it on the retina.

In a camera focussing is done by altering the distance between the object and the lens, but in the eye it is done by altering the curvature of the lens. By this device near as well as distant objects can easily be seen by the eyes. This is called the Power of Accommodation. The nearer the object the greater the amount of accommodation necessary to focuss it properly and so the greater and more fatiguing the effort, as the muscles have to remain contracted all the time the eye is accommodated. This is the reason why close work should not be continued too long and the object to be looked at never brought closer than ten inches. This is particularly important for children.

The lens in a child's eye is very elastic and objects can be focussed when only about four inches away. This makes the lens change its curvature more than it should, and if this practice is continued, the child becomes short-sighted or myopic.

Filling the space between the cornea and the lens is a fluid called the Aqueous Humour. Between the lens and the cup-shaped retina is a jelly like mass the Vitreous Humour.

The eyeball is moved by six muscles, attached to its outer coat. Normally their movements are perfectly co-ordinated, but sometimes it is not so and a squint is produced.

Sometimes a child is born with an eyeball which is too long from back to front. This condition, as has already been mentioned, may also be produced by incorrect use of the eye

when it is young and elastic. Only rays from near objects can then be focussed : distant things will look blurred. This is Myopia or short sight and can be compensated for by spectacles with concave lenses.

In some cases the eyeball is too short and can focuss rays from distant objects but cannot become thick enough to bring on to the retina rays from near objects. This is Hypermetropia or long sight and can be compensated for by using convex lenses.

In the dark or when seeing distant objects, the pupil is dilated to allow as much light as possible to come in. In strong light or when looking at near objects, the iris is contracted and the pupil becomes smaller. This protecting of the eye against too strong light is very important. On the other hand when reading a book you should have a good light and not a flickering one such as fire light.

The eye is also responsible for recognising colours. The normal eye can distinguish all the seven colours of the spectrum of which white light is made up. But some people are colour blind and cannot appreciate the different colours correctly. The most common form is red-green colour blindness, which means the sufferers cannot distinguish between these two colours.

We can be easily deceived by our eyes and a large number of Optical Illusions are known.

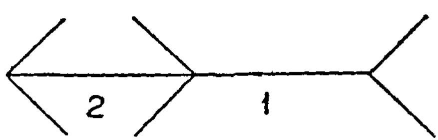


Fig. 51.—Optical Illusion.

The two horizontal straight lines 1 and 2 are equal in length ough 1 seems longer than 2.

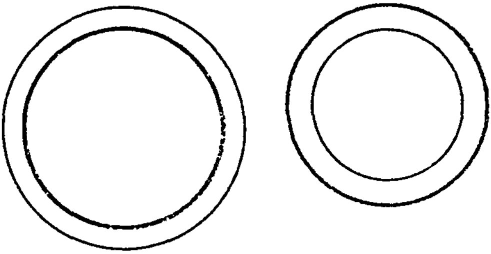


Fig. 52.—Optical Illusion.

The thick circles are equal in size but one appears to be bigger than the other.

The Ear. The ear is a complicated structure. As far as hearing is concerned, it is essentially a device for taking up the vibrations of the air by which sound is produced and transmitting them to some specialised nerve-endings from which impulses are sent to the brain.

The ear is made of three parts : external ear, middle ear and the internal ear.

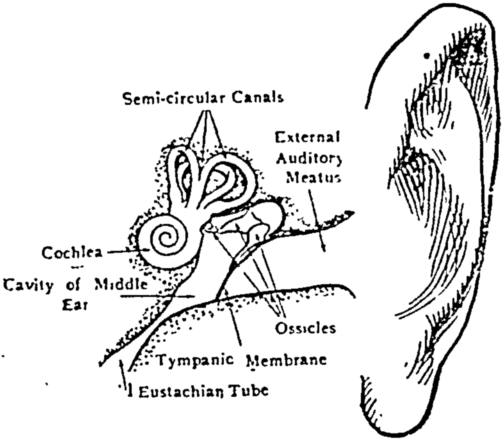


Fig. 53.—The Ear.

The External Ear consists of the leaf-like outgrowth, called the Pinna, and the Auditory Canal. (The pinna is the concave cartilaginous part and this is popularly ca led the ear).

The Auditory Canal is a tube about one inch in length down which the sound waves travel. This is closed at its inner end by the Tympanic membrane (Drum). The drum vibrates when the sound waves of the air reach it.

There are certain glands lining the inside of the Auditory Canal and these secrete a sticky substance called the wax, which prevents the insects from creeping into it. Sometimes too much wax is collected and the Auditory Canal gets blocked, resulting in temporary deafness by preventing the air from getting to the drum If this happens, attempts should not be made to clear out the wax by inserting a match stick or any other hard object into the passage.

The drum is only about an inch down and it can be easily injured.

If syringing is necessary. this should be done very gently or the membrane may burst.

Sometimes when batning or swimming water gets into the Auditory Canal. If that happens, turn the head so as to drain out the water end dry the auditory passages carefully.

The Middle Ear is on the other side of the tympanic membrane and lies in a space hollowed out of the temporal bone of the skul. In the side of the middle ear opposite to the drum are two openings, an oval and a round one, which are covered over with membranes. Right across from the drum to the membrane covering the oval window is a series of three very small bones (hammer bone, saddle bone and stirrup bone). The hammer bone is joined to the drum, and the saddle bone connects the hammer bone with the stirrup bone which fits against the membrance of the oval window, and this in turn moves a fluid, called Perilymph, in the internal ear.

The cavity of the middle ear communicates with the pharynx by means of the eustachian tube and by this arrangement the pressure of the air on both sides of the drum is kept equal. This is essential to get the best possible response from the small tympanic membrane.

If the pressure on both sides of the drum becomes unequal due to the blocking of the eustachian tube (on account of cold or the enlargement of adenoids) the hearing becomes defective.

Due to the communication of the middle ear with the throat, the germs from the throat easily cause trouble in the middle ear ; hence the great necessity of keeping the throat healthy.

The Internal Ear consists of the essential hearing apparatus called Labyrinth, located in bony cavities of the same shape. The bony walls of the internal ear form the Bony Labyrinth and the membrane lining the bony cavities is called the Membranous Labyrinth. The membranous labyrinth is filled with a fluid called Endolymph. The space between the bony labyrinth and the membranous labyrinth is filled with another fluid called Perilymph.

The part of the labyrinth connected with hearing is called Cochlea. Here the nerve fibres end in connection with certain fibres, which vibrate. When the stirrup bone pushes against the oval window, its movements are carried by movement of the perilymph and endolymph to these fibres, and when they vibrate, they stimulate the nerve endings connected with them and the nerves take the impulses to the auditory part of the brain, which really hears the sound.

Smell and Taste. It is useful to discuss these two sensations together as people find it difficult to distinguish clearly one from the other.

There are actually only four tastes : Sweet, bitter, sour and salt. The back of the tongue is most sensitive to bitter, the tip to the sweet and the sides to sour tastes. The salt is tasted pretty equally all over.

Before substances can be tasted, they must be in solution. All the other so-called tastes and flavours are in reality smells.

Smell. Nose is the organ of smell. The interior of the upper part of the nose is lined by a membrane called the Olfactory membrane; while the rest of the nose is lined by Mucous membrane.

The upper part of the nose is separated from the brain by means of a perforated bone called the Ethmoid. The branches of the olfactory nerve pass through the holes of this bone and spread over the olfactory membrane.

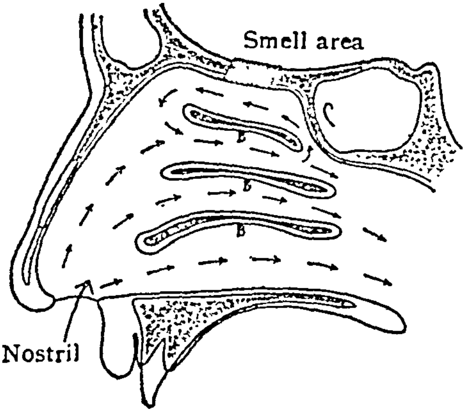


Fig. 54.—Arrows show direction of movement of inspired air.
B=scroll-like bones.

The front part of the nose is chiefly concerned with breathing while the hinder part is used for smelling.

This is why you have to sniff the air when trying to detect the faint odour of a substance. If the passage gets blocked, as it does with a cold, by the thickening of th mucous membrane of the nose, the air cannot be drawn into the olfactory chamber, and the sense of smell is lost - though it is generally interpreted as a loss of taste.

The Skin. When we touch something and feel it, we get a good deal of information about it. We know whether it is soft or hard or hot or cold or pleasant to the hand or painful. This is because the skin has certain sensory nerve endings.

It is generally believed that the sensations of heat, cold touch and pain can be felt everywhere on the skin equally, but in fact it is not so. If we try the effect of putting the point of a thick blunt needle very lightly on to the skin of the front surface of the wrist, we shall discover that in certain small areas there will be an intense feeling of cold. These areas are called the Cold Spots.

Besides the Cold Spots, Heat Spots are also found on the skin.

Pin Spots and Touch Spots are also found on the skin.

Another power of the skin is discrimination of touch. You can feel a pair of compass dividers as two points when only about 1 mm. apart on the tip of the finger but on the shoulder you have to keep them much further apart before they can be distinguished as two.

Thus it is clear that even in the skin, special sensations are associated with special nerve endings. These sensory endings are located in the dermis.

A wonderful quality of the skin is adaptation. The following is a good example of adaptation. Put one hand into hot and the other into cold water and after some time put both the hands in a bucket of tepid water. To the cooled hand it will feel warm and to the warmed one cool.

The bridge of a pair of spectacles may, at first be very uncomfortable on the nose, but when adaptation has occurred, it will not be felt at all.

CHAPTER XI

THE ENDOCRINE SYSTEM

If you will examine the human body, you cannot help seeing certain masses of grandular tissue scattered widely but not seeming to have any reason for being where they are. These are the Ductless Glands (Endocrines).

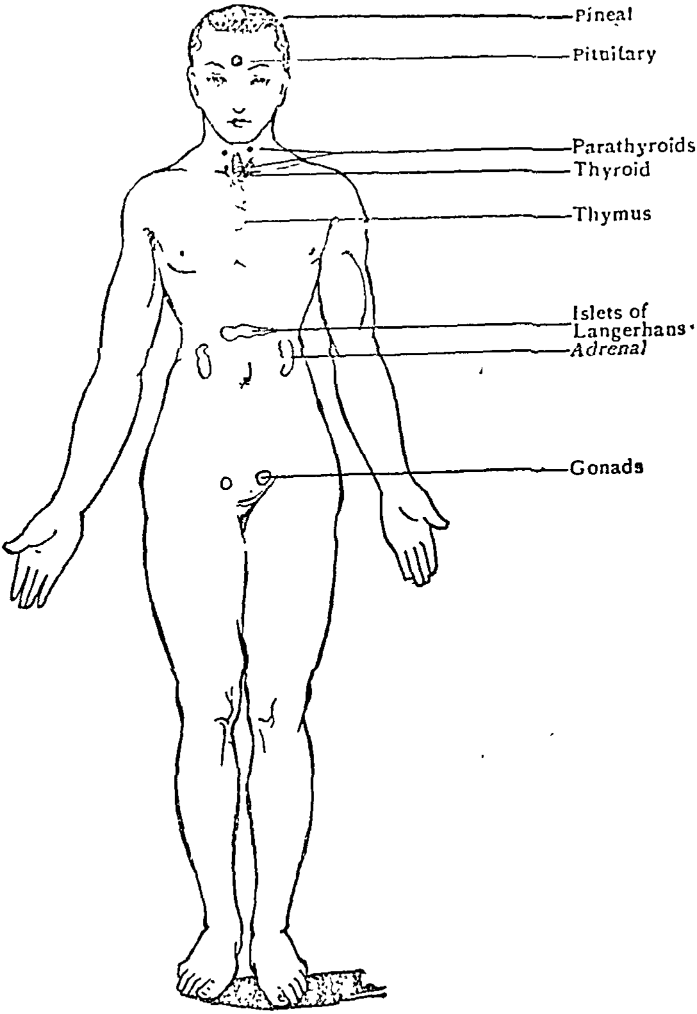


Fig. 55.—Distribution of the ductless glands.

The entire system of endocrine glands consists of :—

(1) The Pineal gland (Epiphysis) situated in the brain posteriorly. Its secretions are partly responsible for regulating the secondary sexual characters, for instance, the difference in hair distribution in male and female (men normally have beards on the face, while women normally do not), and the difference in the pitch of the male and female voice.

(2) The Pituitary Gland (Hypophysis), hanging from base of the brain It controls growth and regulates blood pressure. If the internal secretion of this gland is too little, the individual is a dwarf, and if too much, a person becomes a giant.

Other secretions of the pituitary gland play an important part in the development of sex by influencing the two organs which are ultimately responsible for making human beings into men and women.

(3) **The Thyroid Gland.** This lies in front of the windpipe, but we do not notice it unless it swells and produces what is called a Goitre. Its secretions are important through-

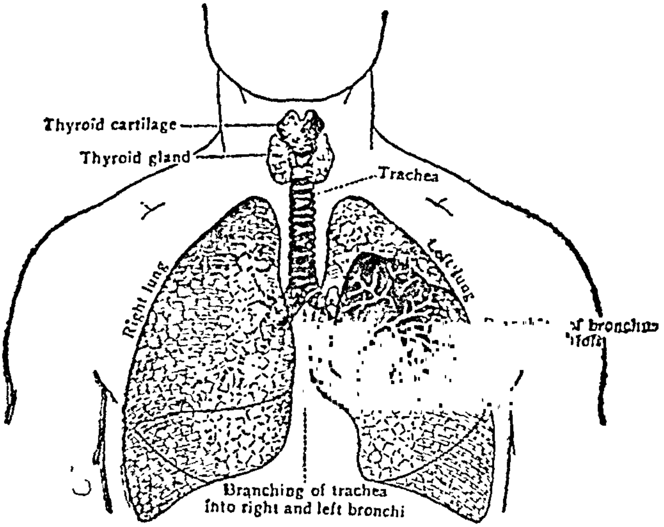


Fig. 56.—Showing thyroid glands.

out life, but specially so in the earlier stages, because without

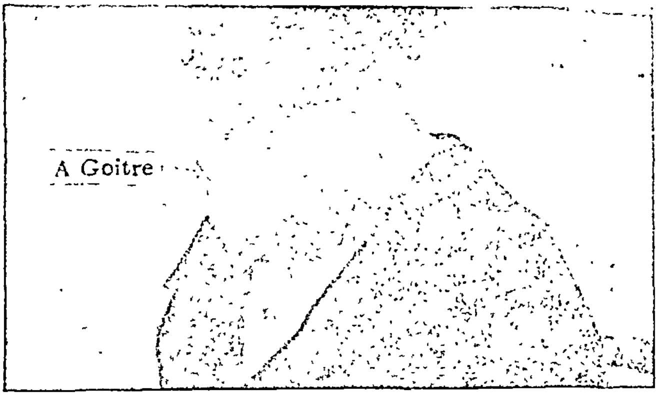


Fig. 57.—A Goitre.

it a baby cannot grow into a normal human being.

About fifty years back a baby born without a thyroid had no chance of becoming a normal person. Instead it developed into a Cretin, a creature stunted in body and mind. Now, as a result of using thyroid (usually sheep's gland) the stunted child develops into a normal healthy individual. If the thyroid does not produce enough of its secretion, then all activities of the body are slowed up. The thyroid secretion contains lot of iodine.

(4) **The Parathyroid Glands.** These are four small bodies attached to the back of the thyroid, but differing entirely from it in structure.

Their secretion has been proved to have a direct influence on calcium (lime) nutrition.

If the parathyroids overact, it may be impossible for the body to make proper bones ; but, on the other hand, if they do not work sufficiently well, or if, they are destroyed completely, the muscle will become exceedingly irritable, and the patient may have cramps and convulsions.

(5) **The Thymus Gland.** It is a large mass of whitish tissue, and can be found in the chest of young people, though it atrophies and almost disappears at the age of 14.

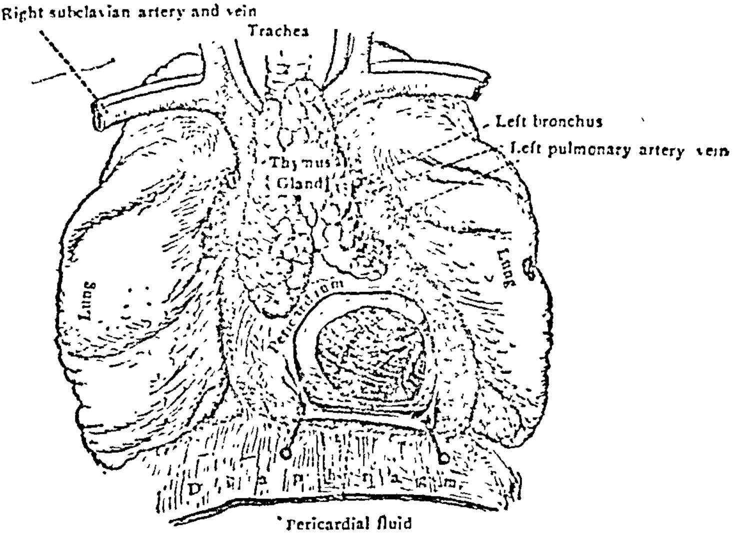


Fig. 58.—The relation of the heart to the lungs, the main blood-vessels, the diaphragm, the pericardium, and the thymus gland. The dissection is made from a twelve-year-old boy. In the adult the same relations exist except that the thymus gland normally atrophies and no longer exists.

(6) **The Adrenal Glands.** One on each side above each kidney.

These glands produce secretions of very great activity; and one of these, known as adrenalin, prepares the body physiologically for a crisis. When adrenalin is poured from the glands into the blood stream, the heart beats more quickly, the blood pressure is raised, and there is an improved circulation through the muscles. The body is thus prepared either for a fight or a flight.

(7) **The Islets of Langerhans.** In the pancreas—groups of cells seen only microscopically and concerned with

corbohydrate metabolism. When they degenerate diabetes results. They make an internal secretion which enables the cells of the body to use sugar.

The internal secretion from the pancreas is called Insulin. When diabetics are given insulin, they can use sugar and are able to take enough food to live a normal life. It cannot be given by mouth because it is destroyed by the digestive juices and therefore it has to be injected.

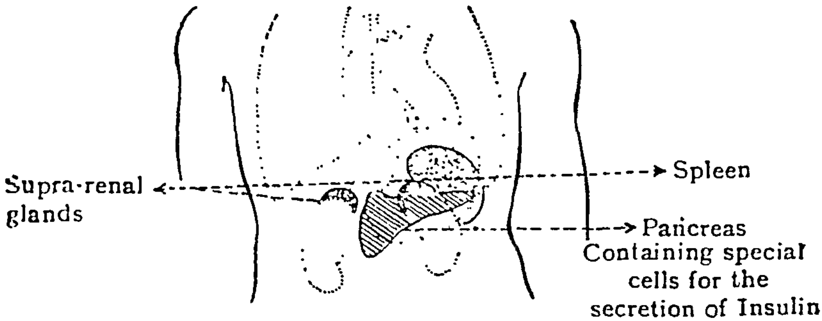


Fig. 59.—The Ductless Glands.

(8) **The Gonads—Ovaries and Testes.** The main function of these organs is to produce the germ cells (ova or spermatozoa). In addition, their secretions govern the secondary sexual characters, such as the growth of hair on the face and upper lip in male.

We know that the ovaries and testes have some general influence on the body, because, when they are removed, a different type of individual results—the eunuch; or when they atrophy in women, unusual fat distribution, facial hair, and other changes result.

These eight groups of glands are called the ductless glands, or the glands of the internal secretion or the endocrines, because they manufacture secretions which are poured directly into the blood stream. These secretions are carried round in the circulation so that they can reach any part where they are needed.

Two general principles about them may be laid down :—

1. They form a connected system. They are interdependent and work as members of a team. The secretion of one balances or supplements the secretion of another. If one is removed, the entire system may be upset. For

example, disease of the islets of Langerhans results in lack of sugar combustion and diabetes.

2. Generally speaking they control four functions—

(*i*) growth

(*ii*) nutrition

(*iii*) sex,

and (*iv*) the vegetative process of gland secretion and involuntary muscle control. These four general functions of the endocrine system represent a summary of all we can prove in the present state of our knowledge.

The years between 12 and 18 are for all boys and girls a period during which the ductless glands are of great importance, because not only do they regulate healthy normal growth in size but because some are responsible for all the physical alterations which change the boy into a man and a girl into a woman.

CHAPTER XII

THE CONTINUANCE OF RACE

To reproduce a new and distinct human body requires the co-operation of two other matured human bodies, differing in structure from one another and known as male and female. Nature seems certain that the plan of having two parents is a success.

The Male and Female Reproductive Systems.

The male has two factories, the spermaries (testes) constantly manufacturing male elements of sperms which are small cells consisting of a head and a moving tail which makes them automatically mobile.

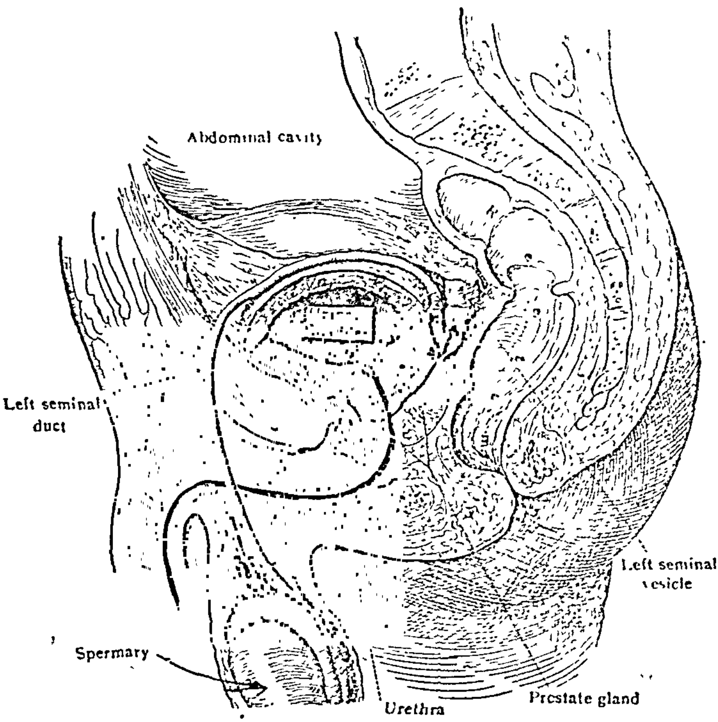


Fig. 60.—The male reproductive system.

From each testis arises a long duct—the sperm duct (vas deferens) which leads into the body cavity and along which the sperms pass. The sperm ducts (right and left) open into two small bags, the *seminal vesicles* just at the base of the bladder. Here the sperms float in a fluid secreted by the Prostate glands, a small gland lying at the base of the bladder. The ducts from the seminal vesicles open into the urethra which ultimately opens out.

The sperms are deposited in the female genital tract or Birth canal. They are mobile, and they are able to enter the uterus and fertilize an egg, provided one is present.

The Female. The female organs of reproduction are all internal and consist of the birth canal; the uterus, a hollow muscular organ lined by a special kind of epithelium; and from each corner of the top of the uterus extend the two Fallopian tubes; and below them are the two ovaries.

The ovaries manufacture eggs (ova) and lie low down within the body cavity, one on either side and each ovary is about one and a half inches long and half an inch thick.

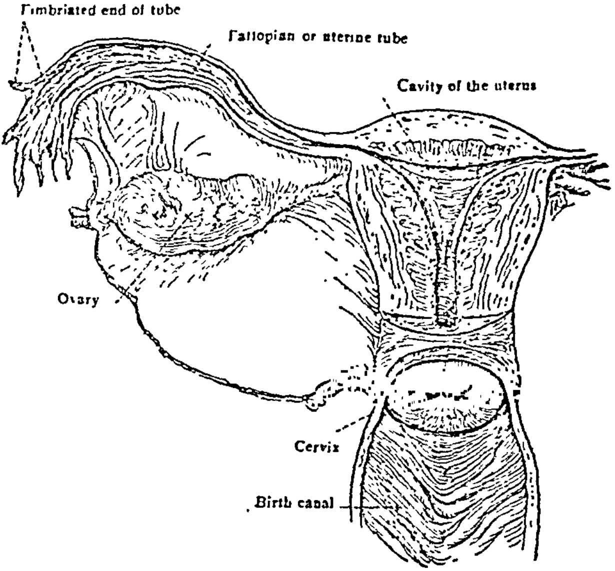


Fig. 61.—The female reproductive system.

Near each ovary is found the funnel-shaped opening of a tube. These two Fallopian-tubes open at the other end into the uterus.

The uterus is a pear-shaped organ about 3 inches long and 1 inch thick, with its wide end upwards, where it is about 2 inches wide. The lower narrow end of the uterus opens into a tube about 5 inches long, the birth canal. The birth canal ultimately opens on to the external surface of the body.

Neither the male nor the female reproductive organs are fully matured at birth. They mature rather suddenly at the age of about 12 to 14 in girls and slightly later in boys. A boy grows hair on his face and body, his muscles become more prominent, and his voice deepens. The changes which occur in the girl are more complicated, because the reproductive function in the females includes not only the formation of the eggs, but also the nourishment of the growing young within the mother's body and the feeding of the young after they are born.

Development. The egg grows in size and a casing of other cells together with some fluid (follicle) is formed round it. The follicle breaks and sets free the egg which is caught by the funnel-shaped mouth of the Fallopian-tube along which the ovum passes The ovum, if it meets with a sperm, is fertilized. The fertilized ovum is now lodged in the walls of the womb where it remains for about 9 months completing its development. The developing child is called foetus. The foetus receives its nourishment from the blood of the mother. A special structure called the *placenta* is found in the wall of the womb and child is attached to it. In the placenta the blood of the mother is only separated from the blood of the child by a very thin layer of cells. This separation prevents a mixing of the mother's blood with that of the child; but oxygen and other materials in the mother's blood can pass through the cells into the child's blood, and carbon-dioxide and other waste products made by the foetus are passed into the mother's blood. As the child grows the womb stretches and the muscles lengthen and become strong until finally at the end of 9 months (gestation period) the muscular walls contract rhythmically and expel the child out of the womb.

Heredity. When the sperm and the egg unite, the essential part of each cell that fuses is the nucleus. Each nucleus has a fixed number of small granular bodies (chromosomes) which carry the characteristics of the parents which make the young like the parents. Healthy parents are thus likely to produce healthy children. Children of a sound stock thus start life with a big advantage.

Part II

CHAPTER XIII

WHAT IS HYGIENE ?

The word Hygiene is derived from a Greek word Hygeia, the goddess of health.

Fig. 62.—The goddess of health.

Hygiene deals with the following problems :—

1. How to live.
2. Where to live, and how to build our houses.
3. Dangers of living in dingy and overcrowded houses and *mohallas*.
4. What food to take.
5. What water is good and safe to drink.
6. Suitable clothing.
7. Physical exercise.
8. Rest and sleep.
9. Dangers of the abuse of tobacco, alcohol and other similar drugs.

Thus we see that hygiene teaches us what to do in order to live a healthy life and prevent disease.

Hygiene may be divided into two sub-divisions :—

(*a*) Personal hygiene or personal health—this deals with the various methods for protecting the health of the individual

Personal hygiene deals with :—

1. Food.
2. Water.
3. Sleep and rest of body and mind.
4. Exercise.
5. Clothing.
6. Cleanliness of the body.

Personal hygiene may also include what is known as domestic hygiene. The domestic hygiene deals with the following subjects :—

(*a*) Locality, construction and ventilation of the house

(*b*) Cleanliness and lighting, warming and cooling of the house.

(*c*) Storage of food and water in the house.

(*d*) Disposal of the refute matter.

(*b*) Public hygiene or public health or sanitation—this deals with the means adopted to guard the health of the general public.

Public health is concerned with taking care of the health of the inhabitants of a town or a village.

Sanitation deals with :—

1. The construction of houses, prevention of over-crowding, etc.
2. Cleaning of streets, drains, latrines, stables, etc.
3. Removal and disposal of all kinds of refuse matter.
4. Water-supply.
5. Prevention of the pollution of air by offensive smells, smoke, etc.
6. Food-supply.
7. The prevention and arrest of infectious diseases.
8. Disposal of dead bodies.

Hygiene, therefore, deals with the laws of health. It is our important duty to take very good care of our health not only for our sake but for the sake of our fellow beings. We never realise what an excellent gift health is until we are ill.

"Cleanliness is next to godliness" is a very wise old saying. A sound mind always exists in a sound body and it is, therefore, essential that we should cultivate the "good habits of life."

Personal hygiene teaches the individual how to keep his body healthy, and public health laws are concerned with taking care of the health of the public in general.

Object of Personal Hygiene and Sanitation. The object is to keep people fit and healthy, and to study the causes of diseases with a view to be able to prevent them.

In order to know how to keep the body fit, it is essential first to understand its construction and functions. These subjects have already been dealt with in PART I of the book.

We must know how to make our environment (surroundings) healthy and also what foods and drinks to take or not to take in order to keep fit.

Individual Responsibility. Every individual has a twofold responsibilty :—

(*a*) *Personal*—he should obey the laws of personal hygiene and keep fit.

(*b*) *Communal*—he should obey the laws of public hygiene and thus contribute his share in the maintenance of public health.

You can visualise the awful results which would follow if no sanitary laws existed. Public sanitary defects must be quickly discovered and the health officials should take immediate steps for their removal.

It is thus the civic duty of every person to help the health authorities in their efforts to improve the public health. People, for example, should get their children vaccinated and thus help to check attacks of small-pox, or inoculated when cholera is raging.

As soon as a small-pox or a cholera case is discovered, it is our duty to make a report about it to the municipal authorities, so that they may take the necessary steps to keep the disease from spreading.

CHAPTER XIV

AIR AND VENTILATION

Air

Composition of the Air. Air is a mixture of gases and its composition is, to a certain extent, variable. Air is seldom pure. The average volumetric composition of pure air is as follows :—

Nitrogen	78·08
Oxygen	20·94
Carbon-dioxide	·94
Other gases	·94
	100

Besides these, there are also present in ordinary air variable quantities of water vapour, ammonia and perhaps ozone. In towns one also finds dust, smoke and fumes from burning of coal, etc.

Properties of the Air. Air cannot be seen as such. It can, however, be liquefied or even solidified by being compressed with great force. If liquid air were to be placed on the skin, it would injure it by freezing it and would then turn at once into gaseous air. Pure air has no smell.

Purification of the Air in Nature. The composition of the air is practically the same all over the world. This remarkable uniformity in composition of the air is due to the purifying effects of the following natural factors :—

(*i*) *The Winds.* They dilute and take away impurities, and bring in supply of pure air to replace them.

(*ii*) *The Rain.* It washes the air and thus removes all the suspended impurities.

(*iii*) *The Oxygen* (*in the air*). It gradually burns and renders harmless the organic matters.

(*iv*) *The green pigment of plants (chlorophyll).*—In the presence of sunlight it takes in carbon-dioxide from the air, retaining the carbon as food and giving up the oxygen.

(*v*) *Sunlight.*—It kills most of the germs suspended in the air. It is a natural disinfectant.

The purest air is found near the sea, on the mountains, and in open tracts of country. The most impure air is found in towns where there are a number of mills.

Air is a Necessity. Human beings and animals cannot live without air. The oxygen in the inspired air purifies our blood, enables us to make use of the food we take, and fits it for the growth of our bodies. It also produces heat and thus helps to keep our bodies warm.

You can live for five or six weeks without food but you cannot live without air for more than a few minutes. Our houses must have a constant supply of pure air. Children brought up in congested houses and localities are liable to be rickety and tuberculous.

Impurities of the Air. The impurities in the air may be divided into the following two classes :—

(*a*) Suspended impurities.

(*b*) Gaseous impurities.

(*a*) **Suspended Impurities.** The presence of suspended particles is displayed when a ray of light enters a darkened room. Only the big particles are thus seen, for, by far the greater number are invisible to the naked eye.

These particles may be divided into two classes, *viz.* (*i*) organic particles, and (*ii*) inorganic particles.

(*i*) The organic suspended particles include disease germs, minute seeds of plants, scales of skin, hair, starch cells, fine pieces of wool, cotton, and silk, and fine fragments of wood.

Some of these organic suspended particles form a powerful factor in the spread of disease. Thus the dried scales of skin from the body of a small-pox patient may carry the germs of this foul disease to a considerable distance.

In a similar manner the dried particles of expectoration from persons suffering from consumption may carry the disease to others. The spores of certain plants (fungi) present in the air may cause skin diseases.

(*ii*) The inorganic suspended matter includes fine particles of coal, sand, salt, clay, etc. These are comparatively harmless unless in excess. When in excess, they irritate the eyes, and the bronchial tubes.

Most of these suspended particles tend to settle down on walls, and floors of our houses and on the various articles of furniture in the rooms.

(*b*) **Gaseous Impurities.** These impurities are poured into the air by (*i*) the respiration of men and animals, (*ii*) by combustion, and (*iii*) by decomposition of organic matter.

Impurities due to Respiration. These are chiefly carbon-dioxide, water and organic matter, consisting of small particles of dead tissue.

Impurities due to Combustion. These are chiefly carbon-dioxide, sulphur-dioxide, water vapour and occasionally carbon-monoxide (carbonic oxide). Coal, if burned with insufficient supply of air (such as in a room with closed doors and windows) produces a considerable quantity of carbon-monoxide.

Carbon-dioxide when present in the air to the extent of two per cent. has no bad effect on health, provided that it is not accompanied by other impurities. Carbon-monoxide, on the other hand, is very dangerous. It is colourless and odourless and so it is not perceived by the victim. The person loses the power of movement, and appears to have no desire to try and escape.

Impurities due to Decomposition. Carbon-dioxide in the air is produced by the process of fermentation and decomposition that are constantly going on. It is accompanied by other foul and injurious gases, such as ammonia, sulphuretted hydrogen, etc. These gases are given off in large quantities from decomposing and decaying matter in filthy streets, drains, cess-pools, stables, cattle-sheds and other similar places.

The foul gases, when poured into open air, have no bad effect on health, but if they get into our houses they are injurious.

Gases from decaying dead bodies of animals cause outbreaks of diarrhœa and dysentery. Gases from sewers often cause vomiting, colic and diarrhœa.

Some throat troubles and various kinds of fevers in children have also been traced to pollution of air with sewer gas. Diseases like cholera, enteric fever, etc., are aggravated by sewer gas.

Gases from stable manure cause nervous depression, gastro-intestinal irritation and sometimes ophthalmia.

Ventilation

Amongst the methods whereby impure air may be purified, ventilation is the most important. Ventilation is the removal or dilution of the impurities of the air of inhabited buildings with fresh air from the outside admitted through the doors and windows. Ventilation should be carried on without producing draughts.

Methods of Ventilation. All methods of ventilation aim at supplying fresh air and removing impure air, and they fall into two classes known as Natural and Artificial, of which the first is very much the better.

Natural Ventilation. This method is used in ordinary dwelling houses and it depends on three natural phenomena :

(*i*) Diffusion of gases.
(*ii*) Wind action.
(*iii*) Convection currents.

(*i*) Diffusion is not very important. It is the tendency of two gases to mix when in contact, and owing to it, if doors and windows be opened, we do have some mixing of inside with outside air, even apart from wind, differences of temperature, etc.

In a ordinary living room, the air is warmer and lighter than the air outside. Diffusion outwards, therefore, will take place at a greater rate than diffusion inwards and fresh air will enter the room not only as a result of diffusion but also in order to equalise the pressure inside and outside the room.

Diffusion, however, is hardly rapid enough to dilute and romove impurities from the air of living rooms. In addition, the organic matter introduced by expired air does not diffuse among the other constituents and therefore tends to remain in the room.

(ii) Wind is more powerful though irregular in action. It acts in two ways –

(a) by Perflation, and (b) by Aspiration.

(a) *Perflation.* – It means the sweeping of air through a room in which doors and windows are open, with the result that stale air is replaced by fresh air.

Perflation takes place very easily if there are doors and windows on opposite sides of a room, and it should be employed in schools, during playtime when the rooms are not occupied.

This method, however, cannot be adopted with safety when the room is occupied.

(b) *Aspiration* is the suction which the wind exerts when blowing transversely across an opening, such as a chimney pot. As the wind passes over the tops of house-chimneys, it reduces the pressure around them, and causes an upward draught in the chimneys.

More air from below flows up the chimney to take the place of air which has been sucked out, and so a current of air passes from the room up the chimney and fresh air is drawn in through the doors and windows.

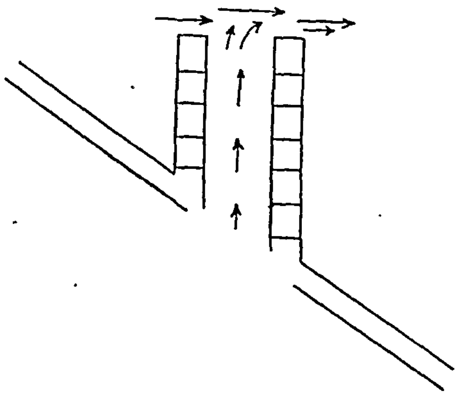


Fig. 63.—Aspiration Effect of Wind passing over a Chimney.

Hence the chimney is a useful outlet for stale air and should never be stopped when fire is not being used.

(*iii*) Convection (movements of air produced by variations in its density due to differences in its temperature)—it means the flow of current of hot air upwards and cold air downwards.

Convection depends upon the fact that hot air is lighter than cold. A fire causes an upward draught of air in the chimney for this reason, and fresh air is sucked towards the fire-place from the rest of the room to take the place of the escaped air.

Air, through respiration, becomes not only stale, but gets warmed. Thus in an occupied room, the warm impure air tends to rise, and if a sky-light or a window be open at the top, it will escape to the outside and fresh air will rush in through the doors.

Inlets and Outlets. In a naturally ventilated building, there must be a sufficient number of inlets for fresh air and outlets for impure air.

Outlets should be placed close to the roof, as the warm vitiated air of the room tends to rise.

The inlets should be placed about six feet above the floor level.

It is advisable to have several small inlets and outlets rather than one large inlet and one large outlet. This will avoid draughts and the impurities of the air in every part of the room will be easily got rid of.

In our country, doors and windows are regarded as sufficient means of ventilation. They should be placed opposite to each other and should be kept open.

Artificial Ventilation. The natural methods of ventilation are sometimes found to be inadequate for large old-styled public buildings, such as hospitals, schools, theatres, etc. Hence artificial means are employed to ensure proper ventilation.

The two chief methods adopted for artificial ventilation are:—

(*i*) *Extraction or Vacuum Methods.*—By these methods impure air is drawn out of the buildings.

(*ii*) *Propulsion or Plenum Methods.*—By these methods fresh air is forced into the buildings.

I. *Extraction or Vacuum methods* :—

(*a*) **Heat.** The ventilation by the fire-place and chimney provides us with a very good example of the action of heat in changing the air of a room. The heated air immediately over the fire expands, becomes lighter than the air of the room and goes up the chimney, while fresh air takes its place and ascends in turn.

The ventilation of mines is based on this principle. A large fire is kept burning at the bottom of one of the shafts, and the air thus heated becomes lighter and passes up the shaft. The cooler and heavier air passes down another shaft and rushes along the various parts of the mine to take the place of the ascended air.

(*b*) **Steam Jets.** At some collieries a jet of steam is allowed to pass into a chimney. This sets in motion the neighbouring air and produces an up-draught.

(*c*) **Ventilating Fans.** A ventilating fan is a wheel-shaped structure with several vanes attached to the axle, and is so arranged that, as the wheel rotates rapidly, air is carried along by the vanes and made to pass along flues or passages. A ventilating fan may be fitted :—

(*i*) To draw out air from a building.

(*ii*) To drive air into a building.

There are some objections against this method, *viz.*—

1. One cannot control the air-supply.
2. The fan may be noisy.
3. The inlets are necessarily low down and therefore tend to cause cold feet.

This method of ventilation is used in the House of Commons in London.

II. *Propulsion* (Plenum methods) : This system has, in the basement of the building, an electric fan which sucks in air through an inlet which is placed high up above the ground. The incoming air is made to pass through shafts,

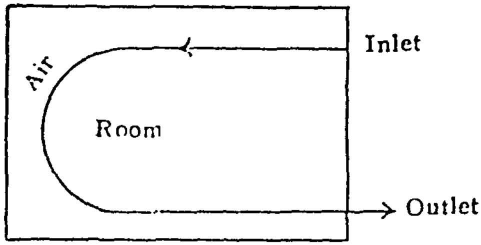


Fig. 64.—Showing air-current in room ventilated on Plenum system.

into each room and ultimately it leaves by an opening low down in the same wall.

This method has its own disadvantages. As a matter of fact nowadays these artificial methods of ventilation are out of fashion.

Whatever system is employed, the following points should always be kept in view :—

1. A thorough and continuous change of air.

2. Draughts should be avoided.

3. The source from which supplies of fresh air drawn should be pure.

Effects of bad ventilation :—

1. Temporary stay in ill-ventilated rooms will produce headache, giddiness and sometimes vomiting.

2. Prolonged stay in ill-ventilated houses will make the inmates pale and weak. They will also be liable to catch infectious diseases such as colds, coughs, tuberculosis, pneumonia, etc.

CHAPTER XV.

WATER

Everybody knows that water is absolutely necessary for the maintenance of life.

The Use of Water. Water is required for the maintenance and growth of life (animals and plants). Without water life could not exist. Water forms about 60 per cent. of the body weight and is needed in all the tissues for the manufacture of the various secretions and for dissolving waste products. We get it not only from the things we drink (water, tea and other liquids) but to a less extent from nearly all solid food.

In the body, it keeps the blood fluid and thus helps to carry food to all parts; to remove the waste material of the tissues and regulate and keep uniform the body temperature.

In the house, it is used to remove and carry away dirt and refuse, to wash the skin, clothes, utensils, etc., and to cleanse the drains.

Man is much more dependent for his life on the adequacy of his water-supply than that of his food. The sensation of thirst is an indication that the body cells are getting dry.

The Composition of Water. Water is a chemical compound composed of two volumes of hydrogen gas and one of oxygen.

Water may exist in the form of either a gas, a liquid or a solid; steam, mist, dew, rain, snow, ice and hailstorms are all different forms of water.

On account of its great solvent power, it is never found pure in nature, but for practical purposes

water that has the following characteristics may be regarded as pure :—

(*a*) It should be colourless, odourless and tasteless.

(*b*) It should be free from nitrogenous organic matter.

(*c*) It should be clear, bright and sparkling.

Sources of Water-Supply. The various sources of water-supply are :—

(1) Rain water.
(2) Upland-surface water.
(3) Springs.
(4) Wells.
(5) Rivers.
(6) Lakes.

(1) **Rain Water** is produced by the condensation of water vapours present in the air. It is the purest natural water, and contains no mineral matter. It, however, contains dissolved gases and may also contain soot, and is, therefore, better fitted for general consumption than water obtained from most other sources. It is liable to contamination by impurities taken up from the surface on which it falls.

(2) **Upland-Surface Water.** Water flowing down hills in small streams and collected in natural or artificial reservoirs. It is good and soft.

(3) **Springs.** Water is sometimes obtained from great depths in the ground through springs. In connection with springs, it may be remembered : (*i*) pure water is obtained from springs which issue from beds of sand and gravel ; (*ii*) hard, but well-aerated and palatable water comes from springs in chalk or limestone.

Beneath the pervious rock there is always, at a certain depth, a layer of impervious character which holds up the water. The surface of this layer is, however, sloping, and the water runs along this until the impervious layer reaches

the surface of the soil, where it comes out as a spring. During hot months, owing to little water soaking into the ground, springs are apt to dry.

Hollow tubes are sometimes sunk deep in the ground in order to get a supply of water, the water in such cases being pumped up. These are known as Tube-wells. Water obtained from tube-wells is the best and safest for drinking purposes. The tube-wells should, however, be protected against pollution.

(4) **Wells.** Wells are artificial springs and they may be classified as follows :—

(*a*) Shallow wells (surface wells) ;

(*b*) deep wells.

(*c*) Artesian wells.

(*a*) **Shallow Wells.** They obtain their water-supply from the surface of the soil, and are, therefore, very easily polluted by impure water and other filthy liquids. This water should not be used. No matter what the depth—these wells only reach the first impervious layer.

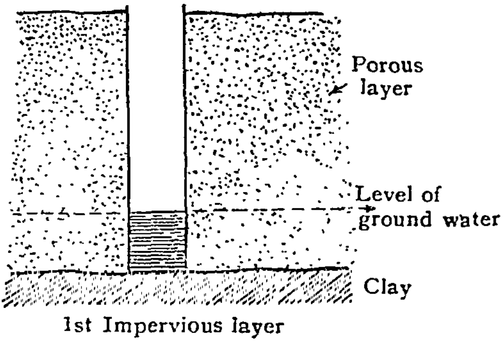


Fig. 65—A Shallow Well.

(*b*) **Deep Wells** are those in which the well passes through an impervious layer to water underneath. Water from this source is, as a rule, good and safe to use.

(*c*) **Artesian Wells** are made by boring and they extend to great depth at times. An Artesian well is, therefore, a deep

well tapping water between two impervious layers in which the water level is at least as high as the level of the ground

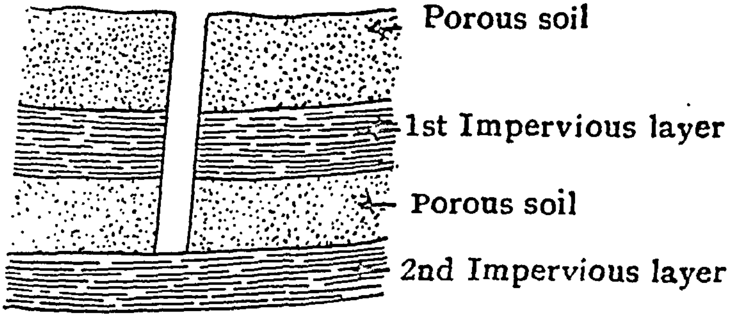


Fig. 66—A Deep Well.

where it is sunk, so that the water rises in the well to the ground level or above it. The water sometimes escapes from them like the water from a fountain, owing to the great pressure to which it is subjected.

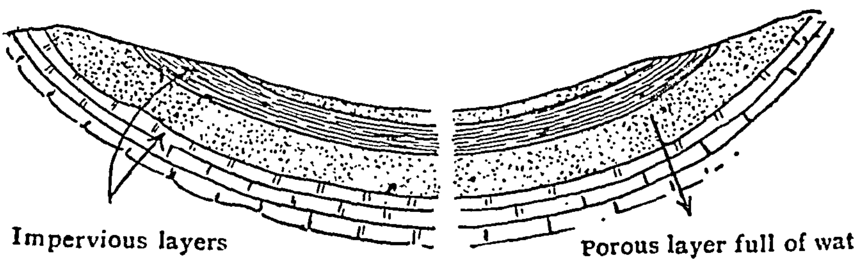


Fig. 67 –An Artesian Well

Although a number of towns in the country have their own water-supply, yet wells are still the chief sources of drinking water throughout most of the villages and even some cities.

The following methods of keeping wells clean should, therefore, be noted :—

(*a*) Keep the mouth of the well closed with a suitable lid, so that dust, dry leaves, and other refuse matter may not get into it.

(*b*) The wells should be made *pucca* with cement plaster this would stop organic matter from the

neighbourhood soaking into the well. The walls should extend two or three feet above the level of the ground forming a parapet.

(*c*) Do not allow anybody to use dirty vessels and filthy ropes to draw water.

(*d*) Get your well emptied and cleaned at least once a year.

(*e*) Get your wells periodically disinfected with potassium permanganate, particularly so when cholera is about.

(*f*) There should be no latrine, soakpit, or any other depression in the neighbourhood of the well.

(5) **Rivers.** River water is well-aerated and not so hard as well or spring water. It usually contains suspended particles, and is liable to pollution by men and animals. It is, therefore, unsafe to drink unless properly filtered or boiled. Owing to the water of rivers and streams being well aerated there is a tendency to self-purification which diminishes the impurities present.

Many large towns get their water-supply from rivers. Agra, for example, is supplied from the Jumna river and Calcutta from the river Hugli The water before use is purified by passing it through various filter beds.

(6) **Lakes.** The lake water is generally pure and soft with scarcely any organic impurities.

Lakes are natural upland-surface collections of water. Water from lakes situated far away from human houses, in places where the land is not cultivated or used for grazing cattle, and where there is practically no decomposing animal or vegetable matter, is good and wholesome. Many large cities obtain their water-supply from lakes

Impurities of Water. The presence of calcium or magnesium salts makes the water hard. Hard water is bad in several ways. It is bad for washing, for a good deal of soap is wasted before a lather can be obtained. The hardness also affects the skin and renders food indigestible Hard water may be made soft by adding to it such substances as sodium bicarbonate or lime.

The chief impurities of water may be divided into two classes :—

(*a*) Dissolved impurities.
(*b*) Undissolved impurities.

Water in the neighbourhood of graveyards contains organic decaying matter.

The undissolved impurities of water consist of the following :—

(*a*) Disease germs (as for example, germs of cholera and typhoid).
(*b*) Eggs of worms, such as round and tape worms.
(*c*) Fine pieces of food and sand particles.

The following table shows the various kinds of impurities found in water :—

Impurities of water

- Suspended
  - Organic
    - (1) Decaying animal or vegetable matter
    - (2) Disease germs
    - (3) Water plants
  - Inorganic
    - (1) Sand particles
    - (2) Mineral matter
- Dissolved
  - Gases
    - (1) Carbonic acid gas
    - (2) Sulphuretted Hydrogen
  - Solids
    - (1) Organic
    - (2) Inorganic

Purification of Water. The process of purification of water consists in the removal of the dissolved and suspended impurities. There are several ways in which water may be purified.

A.—Physical
B.—Chemical.
C.—Mechanical.

A.—Physical Methods of Purification of Water.

(1) **Distillation.** Water is freed from its salts and other impurities by boiling in specially made boilers and collecting the steam in separate condensers, where it forms water on cooling.

The process is known as distillation and the water thus obtained is called distilled water.

In practice this process is never used for household purposes. It, however, very often happens that the drinking water-supply, carried in large tanks in steamers and ships, is exhausted before reaching the place of destination. Under those circumstances the crew and the passengers have to distil sea water, in order to render it fit for drinking and cooking purposes.

(2) **Boiling.** This is a good method of purifying water. Boiling for ten minutes will kill almost every known form of disease germs which water may contain.

When water has been boiled, it must be allowed to cool in covered vessels, so as to prevent the entrance of dust and other impurities. Boiled water is insipid and unpalatable. It is, however, safe which is much better.

B.—Chemical Methods.

(1) **Precipitation.** Alum (*Phitkiri*) is generally used for this purpose. It clears muddy water by carrying the mud and other suspended matters to the bottom of the vessel containing water. It is even believed to kill disease germs. Six grains of alum to a gallon of water are sufficient.

Germicides. The germicides commonly used for this purpose are :—

(*a*) Potassium permanganate.
(*b*) Bleaching powder.
(*c*) Copper sulphate.

(*a*) **Potassium Permanganate.** It acts as a germicide by destroying the organic matter on which disease germs thrive. It is considered to be the best means of cleansing the water of wells which are believed to be infected with cholera germs.

Sufficient permanganate must be added to turn the water very light pink. It is largely used for disinfecting wells in times of epidemics of cholera.

(*b*) **Bleaching Powder.** A solution of this chemical may be made by adding half a tea-spoonful of the powder to a pint of cold water. Add a tea-spoonful of this solution to 10 gallons of water, and in about half an hour, the water is rendered safe for drinking. The bleaching powder sets free chlorine which destroys the disease germs.

(*c*) **Copper Sulphate.** It is used for removing water plants (algæ) in tanks.

C.—Mechanical Methods.

Filtration. The purification of water on a large scale is effected by sand filter beds. The water collected from wells sunk far away from the town, or from a running river or a stream is first passed through settling tanks or large reservoirs where suspended particles collect at the bottom, and most of the germs are destroyed by light and air. About 24 hours later the water is allowed to flow on to other tanks known as the filter beds, which consist of layers of coarse sand and gravel.

Such a filter bed may have 40 inches of coarse sand and 24 inches of gravel in different sizes arranged, so that the upper finer material cannot pass into the lower coarser stuff, nor can the lower material be washed away by the descending water. The filtered water is then collected by drains which convey it to the storage tanks.

For distribution to the various parts of the town, underground 'mains' (iron pipes) are laid. From these 'mains' service pipes run to the houses.

The water from the taps of a filtered town supply is safe and wholesome, and those who live in such towns, should never use well or tank water.

Domestic Filters. Various types of household filters are in the market. The best one is the Pasteur-Chamber-

lain filter. It consists of a cylinder of unglazed porcelain, closed above, and terminating below in an open nozzle. This lies inside another vessel, having a space between the two, both above and at the sides, into which the raw water passes. The water is forced through the pores of the unglazed porcelain cylinder under pressure. It is a reliable domestic filter. It is easily cleansed, as the procelain cylinder can be taken out and the matter on the outside can be rubbed off, the cylinder being afterwards sterilised by boiling.

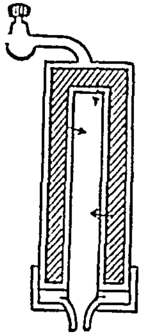


Fig. 68
Pasteur-Chamberlain Filter.

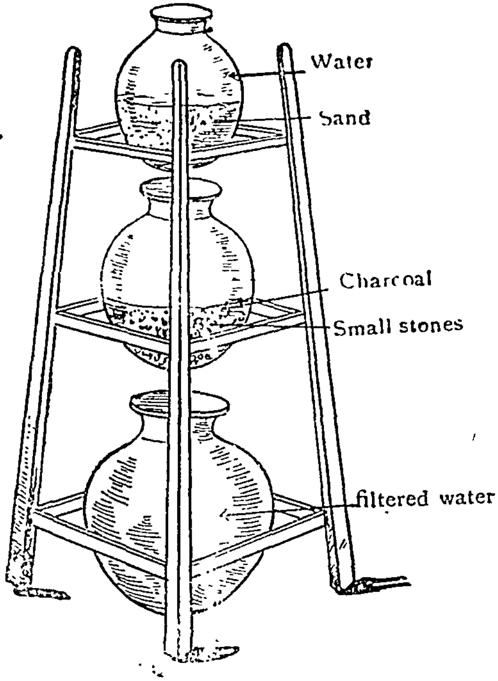


Fig. 69—An Indian Filter.

The Indian Filter. Charcoal and sand are used in the well-known and cheap *Hindustani* filter sometimes known as the *Three Ghurra Filter*. It consists of three earthenware pots (*ghurras*), arranged one above the other in a wooden or iron frame.

The two upper *ghurras* have one or more holes at the bottom stuffed with cotton wool. The filtering materials such as sand, charcoal and gravel should be renewed once a week.

The top vessel containing sand is filled with water which drips into the middle vessel. The middle *ghurra* contains powdered charcoal and a layer of small pieces of stone underneath. From this the water drips into the lowest *ghurra*, where filtered water is collected.

The filter does not, however, remove the germs from the water. The filtered water, therefore, must be boiled before it can be safely used for drinking purposes.

Contamination of Water.

This may take place :—

(*a*) at the source,
(*b*) during storage,
(*c*) during distribution.

(*a*) *Contamination of Water at the Source.*

The well water may get polluted by organic matter from sewage soaking in from leaky drains and cesspools and worse still it may contain disease germs from the excreta of typhoid or cholera patients.

The wells are sometimes polluted by using dirty and unclean vessels and ropes for drawing out water.

Tanks are usually polluted by being used for washing and bathing purposes. Sometimes surface drains from filthy localities open into tanks. Rotten leaves, weeds and other such impurities are also responsible for the contamination of tanks.

Rivers and stream water in passing through cultivated land may contain washings from the surface. Sewage or drainage and washings from mills and factories may also be responsible for polluting it. Sometimes dead bodies of

animals are thrown into the streams and they are a source of contamination.

(*b*) *Contamination during Storage.*

Wooden vessels should never be used for storing water, as decomposition soon sets in.

Copper or brass vessels are the best for storing water for household purposes, but they cannot be used during the summer months as water in the vessels soon gets hot.

In India, earthenware vessels are commonly used for storing water in the house. These vessels should be carefully cleaned and changed as often as possible. Being porous, they are liable to absorb injurious gases and take up dust particles. A *ghurra* or a *surahi* should never be allowed to stand on the ground. These earthenware vessels should always be placed on stools, wooden frames or on clean pucca platforms.

(*c*) *Contamination during Distribution.*

Leather buckets and water skins (*mashaks*) are commonly used for drawing and carrying water. They are usually kept in a very dirty condition and they sometimes form a very good breeding ground for various disease germs.

The best way to tell when water is polluted is the health of the people who drink it. If there is no cholera, typhoid and so forth, the water may be taken as safe and pure. If, however, cholera or typhoid, or diarrhœa breaks out, the water supply should at once be looked into.

In large towns, the water is periodically examined to find out the quality of the supply. It should normally always be done, as prevention of disease is better than cure.

CHAPTER XVI.

FOOD—DIETS

The need for food is obvious but what constitutes a good dietary is not so obvious.

The process of digestion and the main function of classes of food have already been dealt with in Chapters IV and V.

There remain the practical questions as to which foods to choose and which to avoid, out of the bewildering selection presented to us in our country; how food should be cooked; how it should vary with age, work and time of the year; what it should cost.

The body is composed of proteins, carbohydrates, fats, salts and water. Therefore, in order to maintain the body in normal health, it is necessary that the above-mentioned constituents should be in our food supply. In addition, certain elements, known as vitamins and minerals, are essential for good health.

Proteins, carbohydrates and fats are all combustible, and the heat formed on their oxidation is a measure of the energy they can give to the body. The unit of heat is known as the calorie, and is the amount of heat that will raise one gramme of distilled water through one degree Centigrade.

By burning the three main classes of foodstuffs, it has been calculated that:

1 gramme of protein	=4·1	calories
1 gramme of carbohydrate	=4·1	"
1 gramme of fat	=9·3	"

On the average a man needs the following amounts daily:—

Protein	100 gms.
Carbohydrates	500 gms.
Fat	100 gms.

A woman or a child needs less than a man. A child of ten needs nearly as much food as an adult woman and a

child of thirteen needs more—almost as much as a man. One must not, therefore, be surprised at the appetites of growing children. The simple explanation is that they are growing. Thus we see that a man of average *weight and doing moderate amount of muscular work must* have food which will furnish him with about 3,000 calories.

Work and climate also affect the quantity of food. The less the amount of work done by an individual and the warmer the climate, the less food does he or she require.

Vitamins. A note on vitamins is already included in Chapter V. These substances are present, to some extent, in most natural raw foodstuffs. The amount varies considerably in different foods but is always very small, yet the vitamins are an absolute necessity to life and good health.

The Diet. *In the foregoing pages the chemical composi-*tion of foods and the quantities necessary to health have been discussed. But there are wide differences in the quantity and quality of food taken by different people. Some live on rice and vegetables only, while others can live on beans and butter.

Nitrogenous foods are indispensable in a diet. The body will quickly wear away without them. On the other hand, a diet of proteins, salts and water would be equally unsatisfactory in the end, although the body would probably be able to live for a longer time.

Proteins and some non-nitrogenous food (starch, sugar or fat) with salts and water will keep up life indefinitely if they are present in the right proportions.

It should be remembered that fats and carbohydrates, although similar in functions, yet are not mutually replaceable in a diet.

A diet from which carbohydrates are absent, would produce unsatisfactory results, while the total absence of fats from a diet will lead quickly to loss of health and vigour.

The principles of diet may be summed up as follows :—

(1) No single food principle whether nitrogenous or non-nitrogenous can support life for a long time.

(2) Life may be supported on one nitrogenous and one non-nitrogenous substance for a long time, but for a permanency, salts would be needed.

Thus proteins and starches or proteins and fats will support life.

3. The ideal diet consists of both fats and carbohydrates in addition to nitrogenous matter and probably both starch and sugar are necessary.

A proper mixture of more than one form of nitrogenous food is wholesome, and the necessary vitamins must, of course, be there.

A Standard Diet may be defined as a diet suitable for a man of average weight and build, engaged in an active life with a moderate amount of physical work. It must, however, be remembered that exactitude is impossible. Foods of the same kind differ much in composition and individuals also vary in their essential food requirements. Each person must find out for himself the quantity of food that prevents underweight or overweight and keeps him energetic.

The food must be well cooked and appetising. Variety in food dishes is also very important for it excites the appetite.

Food must be eaten slowly and in peace. It must be chewed well so that it may thoroughly get mixed with the saliva. If the food is imperfectly masticated and bolted down hastily, indigestion will result.

The last meal should be taken at least one hour before going to bed.

A hearty meal should neither immediately follow nor precede violent exertion.

Appetite. A healthy appetite is the signal that the stomach with its juices is ready to start work. On the other hand, absence of appetite indicates that there are no gastric juices ready for digestion, and to take food without appetite, is toclog the digestive organs.

Regularity in meals causes the mind to prepare digestive organs in advance with resulting good appetite. Postponement of a meal often results in loss of appetite.

Appetite to be true, must be unspoilt ; hence the perverted appetite, of say, an alcoholic drinker is not to be taken at its face value. In the same way pickles and *chatnies* may cause a perversion of the appetite. Bad smells and ugly sights are sometimes responsible for spoiling one's appetite ; similarly pleasing odours and good palatable food, neatly served, stimulate appetite.

Anger, fear, violent excitement and emotion interfere with the digestion and assimilation of food owing to the diminished secretion of the mouth and digestive organs.

Dangers of Over-feeding. These are less in children than in grown up people, because children are more active physically than are adults and their digestion and excretion are correspondingly active.

The chief effects of over-eating are :—

1. Development of fat.

2 Indigestion, causing pain, flatulence and a general feeling of heaviness and ill-health owing to slow blood poisoning.

3. Too much strain on the kidneys in the case of too much nitrogenous food being taken, thus probably injuring them and tending to kidney disease.

It is no exaggeration to say that excessive eating is more common than under-eating, and is common, at least, in middle and upper classes.

Consumption of about 20 per cent. over the minimum food quota is a good thing but overfeeding, if continued over a long period, immediately leads to much ill-health.

The commonest fault is the taking of food too often. Meals should be taken regularly at fixed hours with about 5 hours' interval between two meals. Three meals a day at intervals of about 5 hours should, therefore, be sufficient. Long continued over-eating with fats and carbohydrates may lead to fatness. Habitual over-eating of protein foods often results in high blood pressure. Later on kidney diseases or gout may develop.

Dangers of Under-feeding. Unfortunately underfeeding is very common in our poor country. In

India, epidemics of plague frequently accompany famine. Under-feeding is very harmful if prolonged and the same holds true if one of the essential food principles be wanting, *e. g.*, protein, fat, or carbohydrates, and this condition is the commoner of the two. It does not show itself in thinness, but some tissue is badly developed, *e. g.*, muscle, bone or brain—or energy and heat may be lacking. An under-fed person is more liable to disease especially consumption than is a well-fed individual. Adequate and good food has an effect on character. "A hungry man is an angry man" is an old saying.

Kinds of food.—Food may be divided into 2 classes :—

(*a*) Animal food.
(*b*) Vegetable food.

(*a*) Animal Foods

(*i*) **Milk** is called a perfect food. It is a liquid consisting of emulsified fat, proteins, salts, carbohydrates and water. After water milk comes in importance to health, because it forms so large a part of the food of babies, young children and invalids. Unfortunately it is easily contaminated and is an excellent breeding-ground for germs.

When milk is allowed to stand, about 10 per cent. of its volume of cream rises to the top. The cream consists of the greater part of the fat, and small quantities of the other constituents. Remove the cream and it is then called skimmed milk. Skimmed milk contains casein, milk, sugar and salts.

Add rennet or a very weak acid or a little curd to milk and it becomes separated into a solid called the *curd*, and a clear liquid known as *whey*. The curd consists of coagulated casein with fat and some sugar and salts. The *whey* contains lactose and salts.

It is necessary to keep milk as cool as possible, otherwise it turns sour.

The Contamination of Milk. Milk even from a healthy cow is often infected with disease germs by the time it is consumed. Milk as a disease carrier has a very good

reputation. When contaminated milk is consumed by people, epidemics of infectious diseases like typhoid, cholera and the like spread.

To prevent disease germs being conveyed through milk, the following points should be noted :—

1. Milk should be kept in clean covered vessels.

2. Milk should always be boiled before use. This destroys the disease germs and renders it more digestible.

3. Milk should not be kept standing for too long after it has been boiled.

4. Pasteurized milk is safe. Pasteurized milk is defined as milk which has been heated to a temperature of about 150°F. for at least half an hour and then immediately cooled to 55°F. or lower.

Adulteration of Milk. This means the addition of any substance which should not be there and which may or may not be harmful to the health of the consumer. Milk may be adulterated in two ways: (*a*) By the removal of cream. (*b*) By the addition of water. The former may be detected by means of a creamometer, which is simply a narrow glass cylinder marked into 100 divisions on its side. It should be filled with new milk and allowed to stand for a few hours. If pure, the cream should form from 10 to 12 per cent. of the whole.

If water has been added to milk, it may sometimes be detected by taking the specific gravity of the milk by means of an instrument called lactometer. It consists of a narrow glass tube about six inches long with two bulbs blown at one end. The upper bulb helps the instrument in floating, while the lower one which is partly filled with mercury or lead shots keeps it upright. In the case of an ordinary lactometer the scale is marked W, 1, 2, 3 and M, meaning

thereby pure water, 1 part of milk, 2 parts of milk, 3 parts of milk, and pure milk, respectively. By floating the lacto-

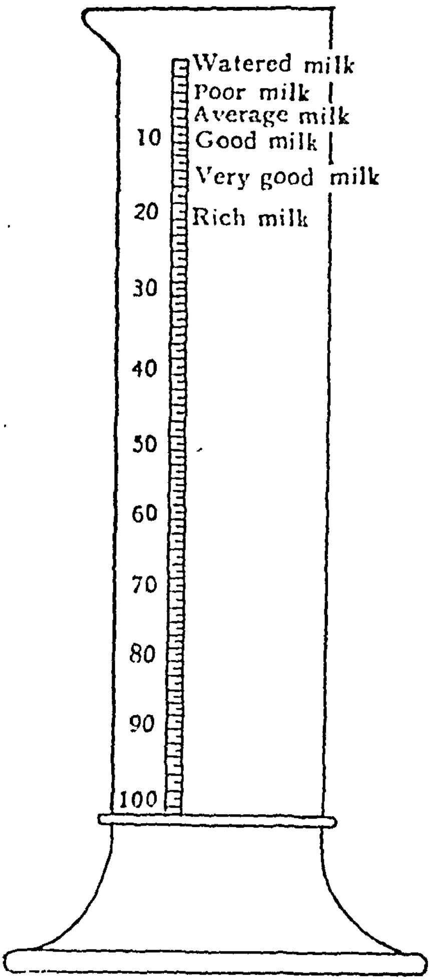


Fig. 70.—Creamometer.

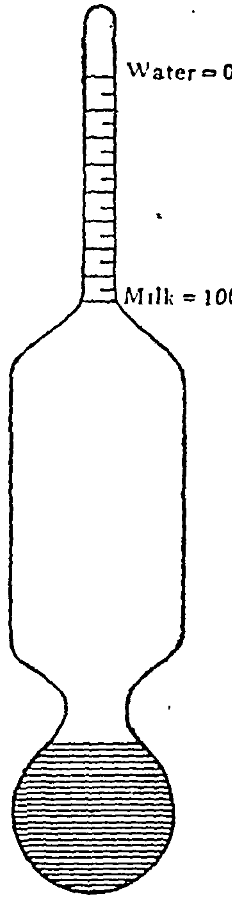


Fig. 71.—Lactometer.

meter in the milk to be tested, we can find out how much water there is in it by noting the mark to which the instrument sinks in the milk. This method is not very reliable.

Starch flour, in the form of *singhare ka ata*, or arrowroot powder, is sometimes sprinkled over milk, which is being

boiled, so as to form a thick layer of so-called *balai* over it. This can, of course, be readily detected by the iodine test for starch.

MILK DERIVATIVES.

1. **Butter.** Butter consists of about 80 per cent fat with a little casein and salts. It is the most digestible form of fat and, therefore, most suitable for infants and invalids. It is practically concentrated cream. It is obtained by churning *dahi* so that particles of fat run together and are separated. The liquid left behind is called butter milk and contains everything in the milk minus the fat For invalids who are unable to digest fat, it forms an ideal food, and is also very suitable for children.

2. **Ghee.** Ghee is butter which has been strongly heated so as to destroy all traces of water and nitrogenous substances found in butter.

3. **Cheese.** Cheese is made from the curd which is separated from the *whey* by straining. It is then salted, and put into moulds and dried under pressure.

The different qualities of cheese depend upon whether they are made from pure milk or skimmed milk.

Cheese is rich in casein and fat, and is, therefore, a very nutritious article of diet. Unfortunately it is not easily digestible, but thorough mastication or grating will make it easier to digest.

(*ii*) **Eggs.** When we realize that a young chick lives on the contents of an egg until it is hatched out, it is reasonable to suppose that an egg must contain all that is required for the construction of the body, and after milk it is regarded as the nearest approach to a perfect food.

The percentage composition of a hen's egg is as follows :—

Water	70
Proteins	14
Fats	11
Mineral salts	5
	100

Eggs are poor in carbohydrates. The salts, moreover, are chiefly found in the shell. Eggs, therefore, should be eaten with plenty of common salt and with slices of bread.

The white of an egg consists of albumen and a good deal of water, the yellow part contains fat, albumen and phosphates.

Because eggs are very nourishing and easily digestible (except when they are hard boiled), they form a valuable food for children and invalids. They become all the more nourishing when beaten up raw and mixed with milk.

To know whether an egg is fresh or stale, any one of the following tests may be applied.

(*a*) Dissolve ½ *chhattak* of common salt in ¼ seer of water, and put the egg in this solution. A fresh egg will sink to the bottom, while a stale one will float on the top of the water.

(*b*) Hold the egg to the light, a fresh egg is clear, a stale one is cloudy or spotted.

Preservation of Eggs. There are several ways of doing this, but any method which by stopping up the pores in the shell prevents the loss of water from and the admission of air into the egg will answer well. The following are some of the methods commonly used :

1. Smear the shell thickly with oil, wax, or gum.
2. Keep the eggs in a mixture of lime and water.

(*iii*) **Meat.** Meat consists largely of water with about 20 per cent. proteins and some fat, the amount of which varies very considerably according to the type of meat.

Liver, generally that of a sheep or lamb, is often difficult to digest, but is one of the most valuable of all the animal foods available for use by man. Iron is also found in abundance which is so necessary for the proper composition of the blood. It is also very rich in fats and contains many other substances which are of great benefit to man.

Poultry and Game. The term poultry includes all domestic fowls, such as, the turkey, goose, duck and chicken.

Game includes various kinds of wild birds, such as the pheasant, partridge and such animals as the hare, etc.

Poultry and game are digestible meats with a delicate flavour, but they are deficient in fats.

Fish, like meat, has a high protein, low carbohydrate, and variable fat content. It is more easily digested than meat. It contains a larger percentage of phosphates than meat, and on this account, it is popularly regarded as a "brain food."

Red and White Meats. Meat may be divided into two classes—red and white. Red meats include mutton, beef, pork. White meats include poultry and rabbits. The white meat is, as a rule, more digestible than the red meat and so, is well suited for invalids. It contains, however, less nitrogen, and is, therefore, less nutritious.

(*b*) Vegetable Foods.

Vegetable foods contain less proteins than animal foods but contain a larger proportion of fats and carbohydrates. In addition, they contain a lot of water and salts.

Vegetable foods may be classified as follows : –

(*i*) Cereals, (*ii*) Pulses, (*iii*) Roots and Tubers (*iv*) Green Vegetables and Fruits, and (*v*) Edible Fungi.

(*i*) Cereals.

The cereals include all the grain-bearing plants, such as wheat, barley, oats, maize and rice. These contain about 70 per cent. of starch and a proportion of proteins varying from 6 to 18 per cent. Besides, they also contain a small and varying amount of vegetable fats and salts.

Wheat. For purposes of consumption, it is ground into flour. Ordinary white flour contains protein and starch ; it is poorer in salts and fat, as the result of the removal of the bran in the process of milling. If grain is broken into small pieces and is used in the form *dalia*, then this is more nutritious than white flour.

Wheat flour is used for making *chapatis*, *double roties*, *poories*, biscuits and various other articles of food.

Barley. It resembles wheat in composition, the chief difference being in the character of the nitrogenous matter.

Barley is deficient in gluten, and for this reason, cannot easily be made into bread unless mixed with wheat flour.

Germinated barley is called malt Extract of malt forms a nutritious and useful food for delicate children.

Rice is nearly all starch and therefore of better use for bodily heat. It is ideal for hot climates. There is very little indigestible residue, and consequently, it forms an excellent food for invalids. Of all the cereals, rice is poorest in protein, fat and mineral salts. Being only rich in starch and deficient in all the other food-stuffs, it is, as a rule, taken with milk, pulses, fish, ghee, etc.

Oats rank next to wheat in nutritive value. They are very rich in nitrogenous matter and fat They contain very little gluten and so cannot be used for bread making.

Maize also is deficient in gluten, and so does not make good bread. It contains starch.

(*ii*) Pulses.

This group includes peas, beans and various *dals*. They all agree in containing a large amount of protein (legumin). This gives them much nutritive value, but they need to be well cooked, otherwise they are extremely difficult of digestion. They are deficient in fat and starch and therefore require mixing with fatty and starchy foods.

Lentil (*masoor-ki-dal*) is the most nutritious of all the pulses, containing much nitrogenous matter and a good deal of iron.

(*iii*) Roots and Tubers.

They consist chiefly of carbohydrates, mostly in the form of starch, and very little other food materials. They include potatoes, carrots, parsnips, beetroots, turnips and artichokes, all of which contain large quantities of starch and water; while beetroots, carrots and parsnips contain sugar as well. They are also good sources of mineral elements.

Onions contain proteins, sugar and a pungent oil rich in sulphur. It is this oil which gives to onions its peculiarly strong smell. They form a nourishing and digestible article of food.

(*iv*) Green Vegetables and Fruits.

Green vegetables such as cabbage, cauliflower, *toris*, *palak*, etc., contain very little nutritive material, and are valuable chiefly on account of their salts. They also contain an indigestible substance called cellulose. This is a substance resembling starch, and serves the purpose of helping the bowels to act freely and thus preventing constipation.

Fruits contain a lot of alkaline mineral salts which keep the blood pure and prevent it from becoming acid. They are also useful in keeping the bowels healthy and active. They are, moreover, one of our most valuable and abundant sources of vitamins—particularly the vitamins B and C. They should, therefore, form a considerable part of our daily diet.

(*v*) Edible Fungi.

Edible fungi, such as mushrooms, contain over 90 per cent. of water and a little nitrogenous matter. They are difficult to digest and are of practically no value as food.

COOKING serves a number of useful purposes, and one must use common sense in deciding whether or not any particular food should be cooked.

Cooking does good because : —

(*i*) It makes starchy food digestible.

(*ii*) It loosens the fibres of meat.

(*iii*) It produces tasty flavours and makes the food more appetising. This is specially true of baking and frying.

(*iv*) It destroys disease germs and parasites which may be in the fresh food.

Against these advantages must be set the fact that heating tends to reduce the activity of the accessory food factors and this is particularly serious in the case of vitamin C.

The Storage of Food. In the house the problem is mainly a battle against disease germs that may get into the food by means of dust in the air or because flies have settled on the food. Many foods may arrive in the house already contaminated to some extent, but no harm may be done and food will not spoil, so long as the organisms are

prevented from growing quickly. (Keeping all food cool, and dry food from getting wet, will, as a rule, prevent rapid growth of germs.) Acid foods go mouldy, sugary ones ferment and protein foods putrefy. Milk is one of the most difficult food to keep because not only is it wet, but in it are all three carbon containing food constituents and so it provides the right kind of nourishment for so many types of disease germs.

Where there is a cool cellar, the problem of keeping food is not difficult, but in most cases, the storage-place for food is either a cupboard or a shelf in the kitchen or living room, and then trouble begins ! The first thing to do is to be sure that dust and flies cannot get to the food and that the food is placed in clean vessels. Secondly, one must see that the food is kept in an airy and as cool a place as possible. Thirdly, in the case of milk, in hot whether it is as well to boil it directly it comes into the home.

During the summer, germs grow quickly in milk and it is probably wiser to boil it as soon as it is delivered. Boiling may reduce the vitamin content but it also reduces the risk of infecting children with germs likely to produce diarrhœa and sickness. In the winter when there is less dust about, milk can be kept cool easily.

How can food be kept cool and in an airy place ? This is where common sense comes in. There may be a shelf or cupboard that will do because it is near the window and away from the fire-place, and provided the food is covered, it will remain in good condition. One may be able to make a simple food-safe with a wooden box, having a door of perforated zinc and this box could be hung close to or just outside the window.

When one thinks of the enormous variety of perishable foods available the whole year round in this country, one realises, how marvellously the problem of feeding the community has been solved during this century. In the so-called 'good old days' some of the methods used for preserving foods were as follows :—

1. Food was dried, salted or smoked, these treatments being used alone or together. Such methods provide us with dried fruits, such as dates and *sultans*.

2. Fresh foods may be heated to destroys disease-organisms and the material while hot sealed from the air. This is the method used in canning and bottling.

3. Sometimes the growth of micro-organisms was prevented by the addition of chemicals.

Such methods as the first two, are likely to make the food deficient in vitamins, and while adequately preserving the food, produce something which has not the same flavour as the fresh food. The last method has the obvious objection that since the preservative is harmful to the germs, it may also be harmful to the human consumer. These methods depend upon the fact that germs are destroyed when heated or when chemicals are added to them or become inactive when their surroundings are dry.

The drama of modern food-preservation and food-transport has been, in the main, built upon the application of the scientific fact that the growth of germs is stopped by low temperatures. Refrigeration (freezing or cooling) now plays its part in all rail—and ship—transport of fresh food, and at the docks and in the wholesale warehouses, there are huge refrigerating-rooms, where the food is stored until it can be released in smaller quantities for purchase by the retailer for consumption.

CHAPTER XVII

ACCESSORY FOODS

Accessory foods may be classified as follows :—

1. Beverages.
2. Condiments.

These accessory foods have no nutritive value, and are useful chiefly owing to their good taste, smell, or for promoting the appetite.

(1) **Beverages.** The word beverage includes everything that is used for drinking purposes.

Beverages may be divided into two classes. Those which do not contain any alcoholic or non-alcoholic beverages, and those which contain alcohol or alcoholic beverages.

The non-alcoholic beverages include mineral waters, tea, coffee and cocoa.

Tea, coffee and cocoa each possesses an active stimulating principle, the effect of which is somewhat similar in each case.

The stimulating principle in tea is known as Theine. The composition of theine is the same as that of Caffeine, which is the active part of coffee. In cocoa, there is a similar substance called the Theobromine.

The effect of tea, coffee or cocoa in moderation is to quicken and strengthen respiration and the heart's action. They stimulate nervous system, and lessen fatigue and the desire for sleep, for which they are valued among students, teachers, lawyers and other brain workers.

Tea is now very largely drunk in our country. It contains two important substances, theine and tannin. Caffeine is a stimulant to the nervous system, it is thus useful in moderation but harmful in excess, since over-stimulation is likely to result in an exhausted condition of "nerve."

Tannin is distinctly harmful because it injures the internal lining of the stomach and hardens proteid food, thus making it indigestible. The longer the tea "stands" after making, the more tannin comes out of the leaves and hence tea ought to be drunk three minutes after making.

It is injurious to drink tea with or immediately after a non-vegetarian meal.

Tea consists of dry leaves of the tea plant which grows in India, Ceylon, China and Japan.

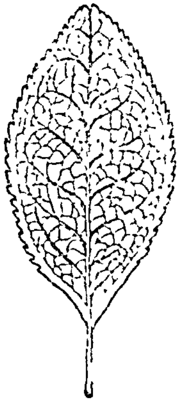


Fig. 72.—The Tea Leaf.

Coffee is obtained from the seeds of the coffee plant grown in Arabia, Abyssinia, Brazil, Kenya, Ceylon and West Indies. The seeds are roasted to a dark brown colour, and then ground to powder.

Coffee is prepared like tea, but may be allowed to stand for 10 or 15 minutes.

Coffee contains the same stimulant, caffeine, as does tea, but it has less tannin, and so is not so likely to cause indigestion. Hence it is a wiser after-dinner drink than tea.

Strong coffee is a useful antidote to alcoholic poisoning.

Both tea and coffee are harmful if made too strong, or drunk too often. A tired body needs food and rest, and not just a stimulant.

Fig. 73.—Leaves, Flowers and Fruit of Coffee Trees.

Cocoa is the seed of a plant growing chiefly in the West Indies. The seeds are taken from the pod and allowed to undergo a kind of fermentation during which the characteristic odour is said to be developed. The seeds are then roasted and the husk removed. Cocoa unlike tea and coffee, is a valuable food, for it contains a large proportion of starch, fats, nitrogenous bodies and salts. Prepared with

milk it forms a highly nutritious beverage with a slight stimulating effect owing to the presence of theobromine.

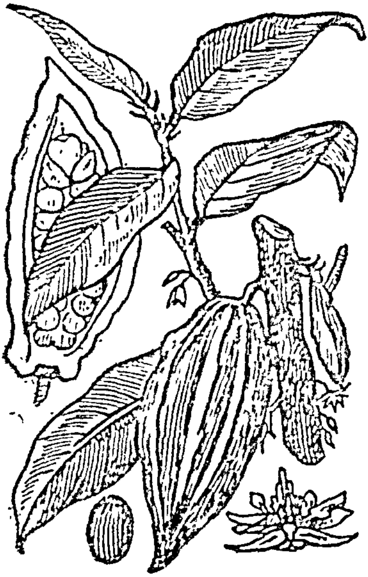


Fig 74.—Leaves, Flowers and Fruits of Cocoa Tree.

Alcoholic Beverages or Fermented Drinks. Alcoholic drinks include *tari*, beer, cider, wines and spirits. Their common constituent is alcohol, and they also contain variable quantities of sugar, acids, salts and certain oils which give to each its particular taste and smell.

Fermented drinks may be defined as those liquids which contain the products of a process of fermentation, the most important product being alcohol.

Characteristics of Alcohol. (*a*) Alcohol is a colourless liquid composed of the three elements : carbon, hydrogen and oxygen.

(*b*) It boils at 78°C and freezes at —130·5°C.

(*c*) It burns with colourless flame leaving no ash, and giving off carbon dioxide and water as the products of combustion. We are all familiar with its use as a liquid fuel in the ordinary spirit-lamp. The "methylated spirit" of commerce is ordinary alcohol mixed with some methyl alcohol, which has a very unpleasant taste and so stops people from drinking methylated spirit which can therefore be sold cheaply, since it is not subject to the very heavy duty which the Government imposes on ordinary alcohol.

(*d*) It evaporates very quickly, taking the heat required for evaporation from any substance with which it is in contact; hence the cooling effect of an alcoholic preparation on the skin.

(*e*) It absorbs water easily.

(*f*) It hardens proteins because it coagulates them, *e.g.*, if alcohol be added to the raw white of an egg, the effect is the same as if you boiled the egg, *i.e.*, the albumen becomes hard and opaque.

(2) **Condiments.** The condiments are substances which are added in small quantities to the food for the purpose of making it more palatable, thereby stimulating the secretion of the saliva and the gastric juice, and thus helping digestion. The condiments are not foods but stimulants. If taken in excess, they irritate and injure the delicate lining of the digestive tract, and thus produce indigestion. Children should avoid condiments as far as possible.

The following are included in this Group. Ginger, onions, pickles and various kinds of *massalas* such as pepper, chillies, mustard, etc.

In moderation, these substances are useful and serve to give variety to the food, as well as to promote a good appetite.

Cooking. Most foods, with the exception of ripe fruits and nuts, should be cooked before being eaten. Cooking accomplishes four things :—(1). It destroys the disease-germs and thus obviates a very common source of infection; (2). It makes the food soft and digestible. There are some foods, such as wheat, pulses, meat and

beans, that the digestive organs cannot digest until they have been cooked; (3) It makes food look pleasant and palatable. As a result of this the flow of the digestive juices is increased and the appetite is stimulated; (4) The warmth imparted to food in cooking helps digestion, and exerts a reviving effect on the system.

Methods of Cooking. Food may be boiled (or steamed), stewed, roasted, baked, fired or grilled. The method of cooking food should be varied as much as possible, otherwise it will lose its relish.

Boiling has for its object either the extraction from the food of its nutritive principles, or their retention in it. This method is generally used in making a soup or broth.

If extraction from the meat of its nutritive principles is desired, as in the case of broth, the meat should be finely cut up and placed in the cold water. It should then be heated slowly (no actual boiling should be allowed), by this means the albumin of the meat is not solidified, but the other natural juices mix with the surrounding water.

If a soup is to be made, the same procedure is adopted with the difference that boiling is maintained for a short while, whereby more of the albumin and juices of the meat are extracted, and the meat itself is rendered still more tasteless and less nutritious.

If the object of boiling is to retain in meat all its flavour and nutriment, then instead of cutting it into pieces, the large piece, as a whole, should be plunged suddenly into boiling water, and the boiling briskly maintained for 5 minutes, after which the water should be allowed only just to simmer. The application of sudden heat coagulates the albuminous matter on the surface of the meat and forms a coat which does not allow the juices of the meat to escape.

Potatoes should be cooked with their skins on, because boiling in the ordinary way removes the greater part of the salts that the potatoes contain.

Boiled food is less tasty but more digestible than when cooked in any other way.

Roasting is conducted on the same principles as rapid boiling, namely the retention of the nutritive juices of meat by the formation of a coagulated layer on the surface. After a short exposure to a sharp heat, the meat should be placed a little further from the fire and roasted more gently. To prevent the meat from burning, the meat is kept constantly enveloped in melted fat.

Roast meat is usually more tasty but less digestible than boiled.

Grilling is a form of roasting which is done by placing the meat on a gridiron over a clear hot fire. *Seekh kababs* are cooked in this way.

Baking is very similar to roasting, with this difference, however, that it is done in a closed oven.

Frying is boiling food in fat instead of water. It is a very poor method of cooking, for the fat that is used forms a coating on each particle of food and is often highly indigestible.

Stewing is really a modification of boiling for extracting juices from the food. The meat is well loosened and so easily digested. It is a very economical method, for the meat as well as the water in which it has been cooked are usually eaten together.

Great care should be taken to protect food from flies and dust, because disease germs thrive much better on cooked food than on raw food.

CHAPTER XVIII

CLOTHING.

In cold climate the natural heat of the body would escape into the air too quickly unless people wore clothes to keep it in, though the amount of clothing necessary varies with the season of the year, age, and the amount of food and exercise taken.

One needs very little clothing even in cold season, when one is taking some vigorous exercise, because the muscles are working hard and producing much heat. On the other hand, a person leading a sedentary life needs more clothes than the person living a physically active life.

Again, when the food contains plenty of fat and carbo-hydrate, less clothing is required than when the food is deficient in these substances.

Old people need warmer clothes for they cannot take vigorous exercise, and a little child requires warmer clothes than an adult because its skin area is larger compared with its body bulk, and so it cools faster.

The Functions of Clothes. The chief functions of clothing may be summarised as follows :—

(1) To maintain the normal heat of the body. The heat produced by the chemical changes of food when in the body, would, but for our clothes, pass from the skin to the external air, because the temperature of the body is nearly always higher than that of the surrounding air.

(2) To protect the body from cold, heat, wind, rain and injury arising from contact with external objects.

(3) To adorn the body and for decency.

Materials used for Clothing. The value of the different materials commonly used for clothing depends upon the particular kind of garment under consideration.

Clothing material may be obtained from animal or from vegetable sources.

Materials from the Animal Kingdom.

1. *Wool.* Wool is obtained from sheep, llama (a kind of camel), alpaca and some varieties of goat. Wool is soft and curly. As a material for making clothes, it has the following advantages :—

(*a*) It is a bad conductor of heat and therefore keeps the body warm. It is used in winter.

(*b*) It absorbs water readily. This is its most important property. During exercise, heat is produced resulting in perspiration; then the heat is reduced, being used in the evaporation of the sweat. When the exercise is over, this evaporation still goes on, taking heat from the body, and if not stopped, the body becomes chilled on the surface.

If a woollen sweater is put on immediately after brisk exercise, the vapour from the perspiration is condensed in the fibres and in the pores of the wool, and gives up again the heat which has been used in turning it into vapour. Hence wool becomes warm and the heat is not lost from the body.

(*c*) It is usually rough and causes a little irritation to the skin which increases the surface circulation. This roughness, however, would cause inconvenience to persons having tender skins. So in this respect, at any rate, this quality of wool may be called a disadvantage.

The *disadvantages* of wool are :—

(*a*) Odours and dirts are easily absorbed.

(*b*) It shrinks after washing, especially if soda is used.

(*c*) After prolonged use, it becomes harder, and less absorbent.

Felt is made of wool fibres matted together by wetting and beating.

2. *Fur* is the natural covering of many animals which live in cold climates. The chief articles made of fur are :

cloaks, waistcoats (*Postin*) hats, caps, collars and cuffs. Felt hats are made of rabbit fur which is made into a paste with a little glue and dye, and then moulded. Fur is one of the warmest kind of clothing, and it looks very pretty. It is very costly and when not in use, it should be kept carefully to avoid it being injured by moths.

3. *Silk* is obtained from the silk-moth. The *advantages* of silk as a clothing material are :—

(*a*) It is a bad conductor of heat.

(*b*) It is soft and smooth and does not irritate tender skins.

(*c*) It is very light.

(*d*) It is much less shrinkable than wool.

(*e*) It is durable and absorbs moisture.

The *disadvantages* of silk are :—

(*a*) It is very expensive.

(*b*) Washing and dyeing of silk is also expensive.

4. *Leather* is made from the skins of animals. It is water proof and is used for making sport jackets, boots, shoes, purses, belts, etc.

Materials from the Vegetable Kingdom.

1. *Cotto* is obtained from the cotton plant which grows in India, Egypt, Sudan and in the United States of America.

As a material for clothing, cotton has the following *advantages* : –

(*a*) It is cheap.

(*b*) It is light.

(*c*) It is durable and wears well.

(*d*) It does not shrink on washing.

The *disadvantages* of cotton are : –

(*a*) It is very absorbent of odours.

(*b*) It is not a good absorbent of moisture, therefore is not suitable for under-clothing, except when cellular woven.

(*c*) It is a good conductor of heat, and consequently, it allows the heat of the body to pass through it.

2. *Linenn* is made from the *fibrous* stems of the flax plant. As a material of clothing linen has the following *advantages* :—

(*a*) It is fine and smooth.

(*b*) It is very cool for the skin.

(*c*) It is stronger and more lasting than cotton.

(*d*) When starched the surface becomes smooth and glossy. It is, therefore, largely used for making collars, cuffs and shirt-fronts.

The *disadvantages* of linen are :—

(*a*) It is a poor absorbent of heat.

(*b*) It is a better conductor of heat than cotton. It cannot be used for under-clothes.

(*c*) It is more expensive than cotton.

3. *Artificial silk* is obtained from wood pulp or cotton after chemical treatment. Artificial silk in its qualities is probably about half-way between wool and cotton, but it has one special advantage in that it lets through the rays of sunlight that are good for the body, and enables the body to make its own vitamin D from substances in the fat lying beneath the dermis.

4. *India rubber* is obtained from the juice of plants which grow in Africa, East Indies and South America. It is soft, flexible, elastic and strong. It will not let in water, but equally it will not let out air, and so is an uncomfortable material and gives one a sensation of stuffiness. It is chiefly used for making water-proofs, overshoes, bathing caps, etc.

Some important points about clothing :—

1. They should be non-irritating to the skin.

2. They should be non-poisonous to the skin, *e. g.*, dyes causing dermatitis (skin disease).

3. They should not be too inflammable.

4. They should interfere as little as possible with the normal functions of the skin.

Clothing to be hygienic, must fulfil the following conditions :—

1. They must be made of suitable material which must be—

(*a*) A bad conductor of heat.
(*b*) Good absorber of water, and
(*c*) Porous.

2. Clothing should be made as light as possible, permeable to the air, not becoming wet with prespiration and not clinging to the skin when it becomes wet.

Tight clothing must be avoided, for, they possess the following disadvantages :—

(*a*) Tight clothing is not so warm as loose clothing, for the latter imprisons more air than the former, and as air is a non-conductor of heat, it helps in keeping in the heat of the body.

(*b*) Tight clothing interferes with the natural movements of the body. Tight shirts, tight bodices, etc., interfere with the free movements of the body.

(*c*) Tight clothing is liable to displace internal organs

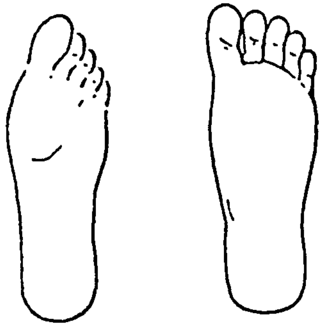


Fig. 75

Foot deformed by pointed boots. Natural foot.

and produce various ill-effects in different parts of the body. Tight boots or shoes produce corns and bunions, and if too tight, the toes are forced one over another and the foot becomes deformed.

Tight corsets are responsible for serious injury to health. Fig. 76-A shows you the natural shape of the twelve pairs of ribs which surround the heart and lungs. Immediately underneath the lungs, and separated from the diaphragm, are the stomach, liver and other vital organs. When tight lacing is used, the ribs are pushed inwards, (Fig. 76-B) the

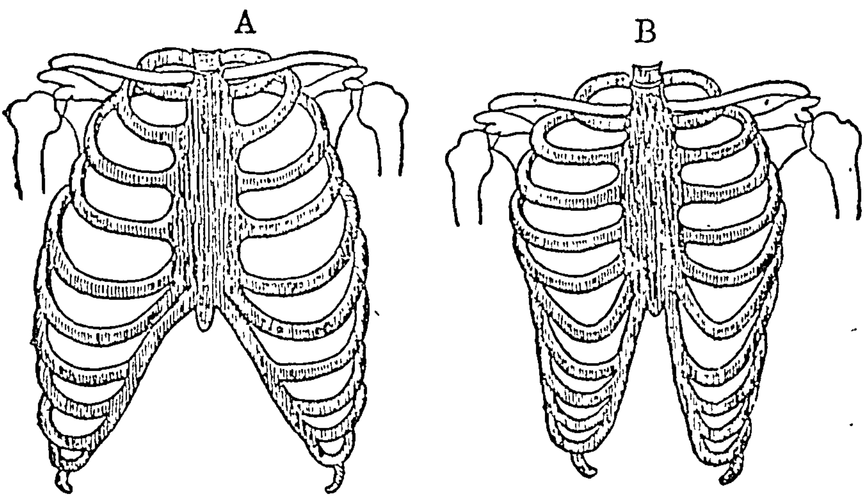


Fig. 76.—Natural Chest Deformed Chest

size of the chest is reduced, the lungs cannot expand properly, and the important organs of digestion are pushed out of place and compressed. Tight corsets thus interfere with normal respiration and digestion.

(*d*) Tight clothing may interfere with free circulation of blood. Tight shoes, collars, corsets, tight belts and garters impede the circulation of the blood.

in the parts affected, and may produce congestion in other parts.

Fig. 77—Scabies.

3. Clothing should not be excessive. The amount of clothing worn should be just sufficient to prevent the body from feeling cold.

Those who wear too many clothes are liable to catch chills, for under the burden of excessive clothing, the skin cannot act as the regulator of the body temperature. Further, the wearing of too many clothes is waste of energy, because the heavier the clothing the more energy is expended in carrying it.

4. Clothing should be properly supported. As many garments as possible should be supported from the shoulders and not from the waist. The practice of hanging heavy skirts from the waist is an injurious one. The important organs in the lower parts of the body are liable to be displaced by the pressure.

The colour of clothes is also of some importance. White and light colours reflect heat, while the black and dark ones absorb heat-rays; and this probably explains why it has become the custom to wear light colours in summer, and conversely to wear dark clothes in the winter.

The main characteristics of the clothing suitable for the different parts of the body are :—

1. *Underclothing.*—Wool is at once the safest and best ; silk or artificial silk may be used.
2. *Head dress.*— Light and porous.
3. *Foot-wear.*— The toes should not be squeezed out of line. The soles should be flexible and heels low.
4. *Trunk.*— Avoid tight lacing, for, it interferes with respiration and digestion.

Clothing for Children.

It is quite common to find children of middle class families overclothed. On the whole, a woollen garment (either vest, or shirt) is best next to the skin in winter.

Handkerchiefs should be regarded as an absolute necessity. The disgusting state of many children's noses, owing to lack of handkerchiefs especially in winter, is only too well-known by the school teachers, and this condition leads to sores on nostrils and lips, and to mouth breathing, since the nose is blocked up with mucus.

Handkerchiefs of very cheap materials can be made and should be supplied to the children.

CHAPTER XIX

CLEANLINESS.

Careful investigation has proved that the health of people living under similar conditions depends largely on their personal habits of cleanliness or otherwise.

We want, therefore, to develop habits of cleanliness in children from the earliest age, and to reinforce the habit by knowledge in the case of boys and girls.

Sir George Newman once remarked that cleanliness was one of the chief aids in health. Besides being one of the chief preventive methods against disease, it is a social virtue and thus develops self-respect.

Unfortunately dirt and carelessness go hand in hand with poverty. Early training is important so that the habit of cleanliness may be firmly ingrained in the mind.

Boys should remember that cleanliness and tidiness are a communal virtue as well as a personal one.

Washing. It must be remembered that the caustic action of soap destroys many disease germs. In addition the bathing of the body with soap and water seems to prevent the accumulation of the disease germs.

The dirty and unclean appearance of young children is, of course, a reflection on the parents and the home. Normally, clean children are the objects of admiration ; continual cleanliness has a powerful influence on the mental complexes.

Washing the hands before meals, teeth cleaning, brushing the hair, and regular bowel action are all habits that are acquired by proper early training.

Want of sufficient soap and water leads to clogging of pores of the skin, thereby interfering with its functions.

CHAPTER XX

PERSONAL HYGIENE OR PERSONAL HEALTH.

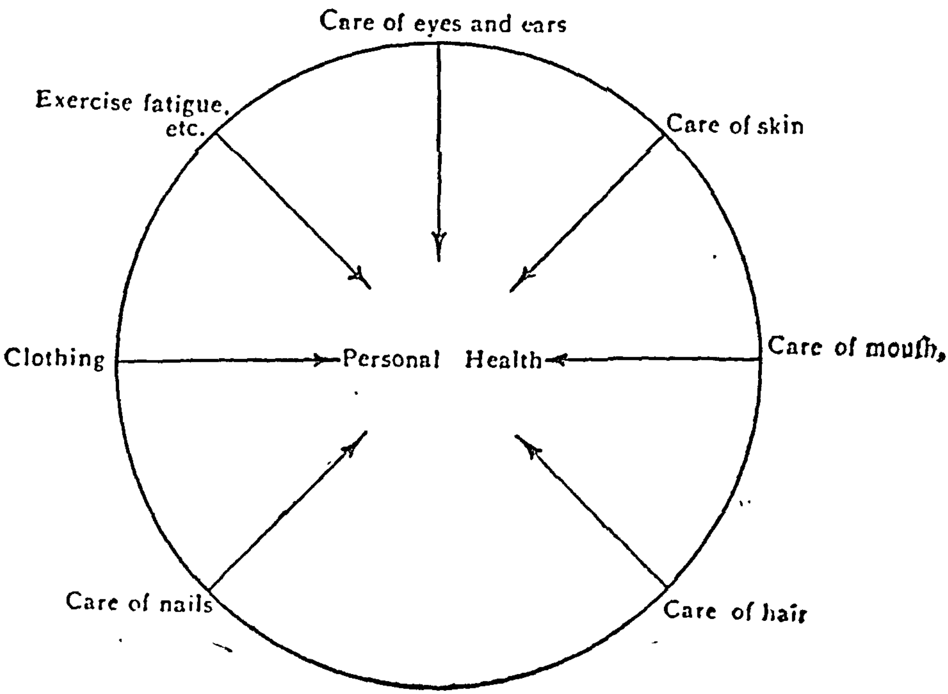
This deals with the various methods of protecting and improving the health of the individual. The judicious combination of exercise, rest and sleep plays a very important part in the health of the individual.

Personal health deals with :—

(*a*) Care of skin.

(*b*) Care of mouth, teeth and bowels.

Care of hair.



(*d*) Care of nails.

(*e*) Clothing.

Exercise, fatigue, rest and sleep.

(g) Care of eyes and care of ears.

(a) *Care of Skin.* A healthy skin is clear, smooth and firm. Cleanliness of the skin is very essential for the upkeep of the health and the growth of the body. If the skin be left unwashed, the following disadvantages result :—

1. It becomes covered with a layer of dirt, consisting of the horny surface scales of the epidermis, the solid part of the sweat, and dust particles, disease germs, etc., trapped by the sticky, oily matter on the skin.

2. Decomposition sets in and we get the very objectionable smell and dirty-skin. It causes skin diseases and encourages various parasites to flourish.

3. The sweat-glands are blocked, so that the sweat is, to a large extent, prevented from escaping, and the skin becomes charged with waste matter.

4. ~~The skin,~~ therefore, becomes unhealthy, and develops pimples, blotches, etc., and extra work is thrown on the other excretory organs, such as the kidneys, which try to get rid of the waste matter which should be eliminated by the skin. Heat retention also follows, the results of which are injurious.

5. It reduces the sensibility of the skin. The skin is supplied with innumerable nerves which supply it with the sense of touch. If the skin is dirty, it is naturally less sensitive. This is a danger to health. The nerves govern the blood vessels which control the temperature of the body, and if the nerves do not work properly neither will the blood vessels. The result is that the temperature of the body is not properly regulated and there is tendency to catch cold.

Cleanliness of the Skin. The skin must, therefore, be kept scrupulously clean and the underclothing must be washed and regularly changed. The clothes should be thoroughly aired and damp clothes should be changed at once, as they are liable to chill the body.

(b) *Care of Mouth, Teeth and Bowels.*—Mouth must always be kept clean. It is wise to keep the mouth

cleared of food particles whose presence may encourage tooth-decay (caries). When one is asleep, and not moving tongue or teeth and no saliva is washing out the mouth, there is much more chance of germs to grow; and therefore the most important moment for cleaning the teeth is just before getting into bed. After that nothing should be eaten.

Nothing should be eaten in the morning until the mouth is thoroughly cleaned.

Teeth. The importance of the right kind of food for mother and child and the use of jaws and teeth is very great. It is illustrated by the facts observed amongst various uncivilized races possessing very good teeth but no tooth brushes.

However, in civilized countries, it is essential to clean teeth. Teeth should be regularly cleaned preferably after every meal, but the most important time is last thing at night, after which no food should be eaten. This can be done naturally to some extent, by eating a hard crust or apple at the end of a meal. If teeth are not regularly cleaned, tartar (hard yellow matter) collects on them and tends to injure them.

The use of a fresh green *neem* or *babul* stick for cleaning teeth is cheap and good. The large varieties o tooth powders and tooth pastes in the market do good to nobody except the manufacturers.

The decay of teeth is due to the presence in the mouth of acids which dissolve the enamel, usually where it is thinnest. These acids are produced by germs which are always present in the mouth and which feed on any food left sticking to the teeth, converting it thereby into acids. The enamel having been eaten through, the dentine is next attacked and dissolves faster still because it is softer and soon the pulp is exposed and great pain results whenever food or cold air touches the nerve. Moreover, the contagion spreads to the other teeth.

Effects of Dental Decay

1. Digestion and nutrition are weakened.
2. Poor physical and mental development.

3. The pus formed in the tooth is swallowed and sets up slow blood poisoning—hence headache, skin irritation, etc.

4. Loss of sleep and restfulness.

5. The pus makes the breath smell foul and unpleasant. Gum-boils appear and cause a good deal of pain.

6. Bad teeth disfigure the owner.

7. The constant irritation of bad teeth often sets up enlarged lymphatic glands, tonsils and tonsilitis, and the unhealthy tonsil is probably the gate through which rheumatism enters.

The dental decay can be prevented to a large extent, by seeing that the food especially that of children contains sufficient lime salts and vitamins A and D. A contributory cause of dental decay is effected by cracking of the enamel. Cracking hard nuts with the teeth, cold drinks after hot food and the passage of cold air over the teeth, as it happens in the case of mouth-breathers, all cause fine cracks which act as starting points of decay.

Care of the Bowels.—The bowels should act freely at least once, preferably twice a day. The best methods to secure this are:—

(1) Take a proper amount of exercise daily.

(2) Cultivate the habit of emptying the bowels at the same time each day. Each habit in life, including that of the action of bowels, is dependent upon an association with certain routine events. One can see, therefore, that if the routine changes, as it may do by a change of work or during a holiday, some habits may be upset. One knows from experience that the bowel action habit is in many people easily upset; and it is, therefore, wise when there is a change of routine, to pay special attention to factors of diet and exercise which help bowel action. It should be remembered, however, that there is no cause to be

worried if, for a few days, the regular rhythm of the bowels is disturbed.

(3) Take wholesome and balanced food.

(4) Drink plenty of water. A glass of cold water taken the first thing in the morning is often found very useful.

(5) Avoid strong purgatives.

Habitual constipation has a bad effect on the health and may lead to serious troubles. It also reduces physical and mental strength. The continued use of mild laxatives (although they are not in themselves particularly harmful) can establish a new habit with the result that the bowels do not act without the stimulus provided by the daily dose. This seems an unnecessary expense and bother in order to promote what should be a normal function.

(*c*) **Care of the Hair.** For the health of the hair, good brushing with a hard brush is probably the most important treatment. The friction of the scalp stimulates the circulation under the skin which is stretched tightly over the bone of the skull and so probably has rather a sluggish circulation as a rule. The activity of the oil glands of the hair is also stimulated by vigorous brushing and gives the hair that glossy look which is very different from the dull, scurfy appearance of unbrushed hair. Hair, like wool, takes up dirt readily and therefore requires washing.

The hair can be kept fairly clean by regular brushing and combing and by frequent washing with soap and water. If the hair is not properly looked after, several skin diseases, such as ringworm, dandruff, etc., may arise, while frequently lice also make their appearance. Short hair is beneficial to health as it enables the health-giving sunlight to penetrate to the scalp and back of the neck and ears. It also very much reduces the chances of infection by ringworm or insect parasites.

(*d*) **Care of the Nails.** Nails are formed by the special horny cells of the epidermis and serve as the most useful protection for the sensitive finger-tips, and for the toes. In the human-beings, the hands are used much more

cleverly than are the corresponding front paws of any of the animals, and unconsciously, we learn as much about the world around us with our fingers, as we do with eyes and ears. The fact that we use the fingers so much, means that the nails get dirty easily, and unless nails are kept short, this dirt is difficult to remove. Dirt in the nails is likely to be a source of infection of food if we touch it and even of ourselves if the nails make sore places on the skin. The hands should always be washed clean before and after meals. Biting the finger nails is a very bad habit. It is unsafe as these germs can be then carried into the mouth.

(*e*) The subject of clothing has already been dealt with in Chapter XVIII.

(*f*) **Exercise, fatigue, rest and sleep.** Exercise is necessary for all periods of life, but especially so during childhood and early manhood or womanhood. It is difficult to remain in good health without taking exercise of some kind.

No part of body or brain will develop properly unless it is properly used or exercised. Moreover, the brain depends for its food supply on the blood, and if the blood sent to it is poor in quality or quantity, the work of the brain at once suffers. One of the main requirements of good blood is vigorous exercise.

Brain and body are inter-dependent and the old proverb "Sound mind in sound body" holds good.

We must, therefore, see that the body gets exercised as well as the mind. Games provide the stimulus of enjoyment, which is so valuable to health of body and mind. "All work and no play" makes each of us dull.

In adults, much depends upon the nature of the daily work regarding exercise that they should take. Thus if a man is doing physical work all day, his muscular system has had sufficient exercise, and mental exercise is what he wants for his spare time.

On the other hand those whose work is of a sedentary nature, such as students, teachers and clerks, need bodily exercise in order to maintain their muscular, circulatory and respiratory systems in good condition.

General Rules for Physical Exercise.

1. For good results, exercise must be taken regularly and systematically, and not indulged in by fits and starts.

2. Every muscle of the body should be given proper exercise. By gradually and steadily increasing their work a set of muscles may be increased in size. The best real exercise of all muscles is probably obtained by a vigorous game of football or by hard riding.

3. Since it is much more tiring physically and mentally than play, physical exercise for young children should be of short duration (15 minutes twice a day).

4. Exercise must be graduated to suit age, otherwise over-fatigue or over-strain or heart trouble may occur.

5. Exercise must be taken in open air whenever possible—if not, with doors and windows open.

6. Boys who have heart disease or spinal curvature or who are convalescing from an illness, such as measles or diphtheria, and are, therefore, in a weak state of health, should have less brisk exercise than normal boys.

7. A woollen sweater or coat is needed for cold weather, to put on after exercise, to prevent chilling.

Effects of Exercise.

1. Muscles get improved and are also brought under the control of will.

2. The circulation of the blood is stimulated by the contracting muscles pressing on the blood-vessels and thus forcing the blood onwards. Muscles contain about half the total amount of blood in the whole body.

3. Respiration is deepened and quickened. There is considerable increase in the amount of oxygen inhaled and carbon-dioxide and water vapour exhaled ; consequently, the aeration of the blood is very much accelerated. Thus a man at rest draws into his lungs each minute about 480 cubic inches of air, but if walking at the rate of 3 miles per hour, he takes in 1500 cubic inches of air.

4. More blood also circulates through the skin, as is indicated by the profuse perspiration which takes place dur-

ing exercise. Thus an extra quantity of waste matter is removed from the body by the skin and the blood is purified more effectively.

5. The lungs increase symmetrically in volume, and with them the chest in which they lie. The increased respiratory capacity is associated with a greater power of resistance, especially to diseases of the lungs.

6. It improves appetite, induces better sleep, promotes digestion, and stimulates the kidneys and bowels, thereby aiding the elimination of waste matters from the body.

7. It tones the nervous system.

Fatigue. Every one knows that people are apt to become clumsy when they are tired or cold or improperly fed.

Fatigue has been defined as " the sum of the results of activity which show themselves in a diminished capacity for doing work." We usually estimate fatigue by our sensations of tiredness, but these feelings are not a trustworthy guide, for we often do not discover fatigue in its earlier stages and the only reliable way of measuring it is by the reduction in capacity for work which it produces.

The performance of work depends on the activities of three parts of the body :—

(*a*) Brain and spinal cord, where impulses originate ;

(*b*) the nerves, which carry the impulses to the muscles ;

(*c*) the muscles which perform the work.

The nerves show practically no fatigue, whilst in the brain, cord and muscles, the cause of fatigue is the accumulation of the waste matters (Toxins) produced by the activity of the cells.

These toxins are gradually carried away by the blood and got rid of by the excretory organs, and when this has been done, the fatigue disappears and the brain and the body are again fit for work. Hence the need for rest after work, for a time sufficient for the elimination of the fatigue-toxins. If this rest is not taken, the fatigue increases until further work becomes impossible.

The brain and the spinal cord are much more fatigued than the muscles, and though a person who is tired from physical work says that his muscles ache, the exhaustion is much more in the nerve-centres than in the muscles. Hence all fatigue, whether physical or mental, is really chiefly nervous.

It is important to remember that the fatigue poisons are passed into the blood and the blood circulates through the whole body and brain, therefore the whole body and brain are affected by fatigue, whether physical or mental. Hence after a hard exercise, a boy is not able to turn at once to hard intellectual work and do well at it, neither will a boy tired out by brain work do his best at games. In both these cases what is wanted is a little rest, in which the excretory system can eliminate the fatigue-poisons.

Symptoms of Fatigue.

1. Reduced capacity for work.
2. Failure in power of concentration, and attention to what is being done, hence slowness and mistakes in work, fidgets, little accidents, such as breaking of tools, etc.
3. Feeling of tiredness and lassitude.
4. Bad postures.
5. Yawning and drowsiness.
6. Facial signs :—
   (*a*) Open mouth (this may be due to other causes).
   (*b*) Frowning.
   (*c*) Relaxation of the muscles of the eyelids, producing puffy lids.
7. If fatigue is continuous, general health and spirits suffer.

The Prevention of Fatigue.

1. Work should not be regarded as pure toil ; congenial work should be a pleasure.
2. Do not work continuously for prolonged periods without "rest pauses."

Treatment of Fatigue. 1. A hot bath followed by a vigorous rub down is good because it causes a flow of blood to the skin and therefore more excretion of toxin from the skin.

2. Change of work, when fatigue is mainly local, will rest the tired part, and so it is wise to mix physical with different kinds of intellectual work, thus using different brain centres. Nevertheless as long as a work is being done, general fatigue is increasing, and the only way to reduce this is by sleep.

Rest and Sleep. Without proper rest, the organs of the body would soon get worn out. Rest of body and mind is essential for good health. It is during rest that the repair of the body tissues takes place.

The most absolute rest is that obtained by sleep.

Sleep is the cessation of conscious life. In sleep, heart and breathing slow down, less blood goes to the brain and more to the skin and all the organs have a recuperative rest.

Sleep is deepest and most refreshing during the first two or three hours. Then follows a period of shallow sleep when we get most dreams, these being largely due to external stimuli.

Finally we get a period of deep sleep just before waking.

For good sleep, the following conditions are necessary:—

(1) Fresh air.
(2) Quiet. Sleep in a noisy place is less refreshing than in a quiet one.
(3) Darkness.
(4) **Regularity.** There should be a fixed hour for going to bed. By keeping a fixed bed time, it is easy to develop a sleep habit which is of great value in ensuring the right amount and kind of sleep.
(5) Sufficient but not too much warmth.

Amount of Sleep. Different authorities suggest slightly different periods for various ages, but the following table gives a fair average :—

From	4 to 8	years old child requires	12 hours.
,,	8 to 12	,, ,, ,, ,,	11 ,,
,,	12 to 14	,, ,, ,, ,,	10 ,,
,,	14 to 20	,, ,, ,, ,,	9 ,,

An average adult requires 7 to 8 hours.
,, ,, old man ,, 10 to 12 hours.

Sleeplessness is very difficult to cure, but drugs should be avoided. All sleeping drugs have a bad effect on health.

The best and safest remedies are :—

(1) A little hot food just before going to bed.

(2) No work for half an hour before going to bed.

(3) Plenty of fresh-air exercise during the day.

Care of the Eye. The eye is an important organ and every possible care should be taken to protect it from injury and preserve its powers.

Some of the commonest causes which affect vision are :—

(1) Defective lighting of the rooms.

(2) Light falling directly on the eyes.

(3) The use of books or newspapers printed in too small a type on glazed paper.

(4) Reading or writing for too long a time without rest pauses.

(5) General bad health.

To keep the eye healthy, the following rules should be observed :—

1. Avoid reading in bed.

2. Avoid conditions of work which are likely to injure the vision.

3. Get the eye-sight tested periodically to detect any defects.

4. Get spectacles suited to remedy any defects which are found.

Care of Ears. The ear is a very delicate organ. It is for this reason easily injured. Diseases of the ear are extremely common, and when not properly treated are apt to cause defective hearing and even deafness. The causes of deafness are colds in the head, cold air, exposure to wet, damp feet, chills after exercise, obstructed nostrils, enlarged tonsils, and wax in the ear.

Cold in the head and bad throat often lead to inflammation of the middle ear. Bad teeth often cause severe pains in the ear.

After the daily bath, the ears should be wiped dry with a towel, and if water has entered the ear passage, it should be allowed to run out upon a towel or cloth by turning the head to that side.

Always avoid trying to clean the ears by putting sticks or twisted ends of linen into them, as there is danger of rupturing the drum. In fact, nothing should ever be pushed into the ear for any purpose.

In case an insect goes into the ear, pour a few drops of warm olive-oil. This will cause the insect to come out or will kill it, and then have the ear syringed by a doctor.

CHAPTER XXI

HEALTH AND INFECTION

Infectious Diseases. These are due to germs. Germs belong either to the plant kingdom, forming the class of microscopic and very simple plants called Bacteria or, more rarely to the lowest group of the animal kingdom (Protozoa).

It is important to remember that an attack of infectious disease always arises from a previous case though the connection may be almost impossible to find.

All disease germs are exceedingly small. Bacteria are colourless, maintain their respective shapes by possessing a tough cell-wall, and multiply by a process of fission. In an ideal environment they are able to multiply to an enormous extent : for example a simple cholera germ can multiply 17 million times within 24 hours. Many bacteria have varying resistance to external influences, such as heat, cold, air and moisture. Many produce poisonous substances called toxins.

The term 'communicable' is now generally used, and includes all infectious and contagious diseases.

The infectious or contagious diseases may be classified as follows :—

(1) **Endemic.** These may or may not be communicable from one individual to another and may be said to belong to the place and not to the people, and so are always found in certain places as a result of unhealthy surroundings. Thus malaria is common in certain tropical countries, and rheumatism occurs in damp localities.

(2) **Epidemic.** They are always communicable and may spread very quickly from one person to another and from place to place.

Epidemic diseases include : small-pox, enteric feve (typhoid), measles, whooping cough, diphtheria, chicken-pox, tc.

Relation of Germs and Body.

Whether the germs after entering the human body produce disease or not, depends on the following two factors :—

(*a*) *The Quality and Quantity of the Germs.* The germs may be virulent or weak and to produce disease they must be sufficiently virulent and in sufficient amount.

(*b*) *Condition of the Human Body.*—The body may offer the germs a suitable or unsuitable soil in which to grow. Most people escape, *i. e.*, are immune (non-susceptible) to a disease at any particular time. The extremes of life naturally hold the highest mortality rate. In towns whooping cough and measles are almost confined to children.

In general, any weakening cause which lowers the general tone of the body renders the individual more susceptible. Thus a tired, ill-fed person or one who is living in badly ventilated rooms and getting little exercise is more likely to suffer from an infectious disease than is the person who is in good health.

The defence in our body against disease is known as immunity. It signifies the power of the body to resist the invasion of disease germs and of the consequent attacks of their toxins.

Immunity may be classified as follows :—

1. Natural immunity may be natural to a tribe. Some people are congenitally immune to certain diseases. The Negro, for example, has a natural immunity against yellow fever.

2. Acquired immunity—some persons acquire immunity either (*a*) by a previous attack of the disease, or (*b*) artificially—by the injection into the body of some substance which prevents the growth of germs of some particular disease.

(*a*) Acquired immunity occurs in the natural recovery of certain diseases, chiefly small-pox, and to a less extent, measles, whooping-cough and mumps. People who have suffered from these diseases are

very rarely attacked twice. One attack protects the person from future attacks of the same disease. On the other hand immunity from influenza is of a temporary nature and lasts only a few weeks. Some diseases, such as pneumonia and rheumatic fever, lead to increased susceptibility.

(*b*) Examples of artificial immunity are seen in the protection from small-pox afforded by vaccination ; the injection of anti-toxins both as a cure and as a preventive of diphtheria and lock-jaw (Tetanus) ; inoculation against typhoid fever, etc.

It is now clear that immunity is of the greatest importance to mankind.

How the disease germs get in.

1. Germs may be breathed in from foul air.

2. Germs may enter through scratches or any wound in the skin.

3. Germs may be introduced by bites of parasites such as lice, fleas, mosquitoes and bed bugs. Infection may also reach the body by inoculation through a breach of the surface, as is seen in cases of rabies arising from the bite of a mad dog.

4. Germs may also get in with food and drink. Typhoid and dysentery are caused in this way.

Of these ways, the first is the commonest for in many diseases the germs escape into the air in the breath of the patient, specially when sneezing or coughing, or in the excretions from nose, throat, or lungs, *e. g.*, the expectoration of the tuberculosis patient.

By coughing and sneezing are spread a large number of infectious diseases, such as measles, whooping cough, cold, influenza, diphtheria, tonsillitis, mumps, rheumatic fever, small-pox and plague.

Course of the Disease. When germs succeed in entering the body and causing disease, they rapidly multiply and produce poisons called toxins which are carried by the blood all over the body and cause the symptoms of the disease.

The symptoms increase in severity as the quantity of toxins in the blood increases and they vary in severity according to the constitution of the patient. Meanwhile the white blood corpuscles attack the germs and devour some or secrete substances which dissolve them, so that unless the sickness is so severe as to kill the patient, the number of germs gradually decreases. The excretory organs get rid, by degrees, of the toxins and the patient recovers, retaining in his blood some substance which prevents a second attack.

The successive stages of the disease are as follows :—

(*a*) Incubation is the period between the entrance of the germs and commencement of physical signs and symptoms. It is more or less definite for each disease. Here the first part of the battle is waged between the germs and the white blood corpuscles of the patient. If the body resistance is high, the germs and their toxins are destroyed as soon as they form ; if, on the other hand, the army of attacking germs is too strong either in virulence or in number, then the resistance is overcome and the second stage is reached. During this stage, the patient is liable to become increasingly infectious to other people, as the germs and toxins multiply in his body.

(*b*) Invasion or onset is the period in which the symptoms develop and reach the climax. This stage may be rapid in onset or slow in development.

(*c*) Decline is the period during which the symptoms abate, and gradually disappear, owing to the killing of the germs and the elimination of the toxin.

(*d*) Convalescence occurs when all symptoms have disappeared. It is the time during which the exhausted body recovers its tone.

Period of infection. Generally speaking a disease is not infectious till the symptoms begin, and therefore if the patient is isolated directly the first symptoms appear, infection rarely spreads.

Unfortunately the first symptoms of measles and whooping-cough are not characteristic of these diseases only,

e.g., in measles the first symptom is merely cold in head, and it is several days before the rash appears, whilst in whooping-cough there is no cough at first, but simply the symptoms of a common cold. Hence it is very difficult to stop the spread of these two diseases.

The duration of infection varies according to the disease, and in some it is impossible to make any general statement, as the question can only be settled by examination of the individual case, *e.g.*, in measles a child can be safely allowed to mix with others three weeks after the appearance of the rash, but in diphtheria, the end of infection can only be determined by 'swabbing' nose and throat and microscopic examination of the material thus obtained, to find whether the germ is present or not.

Symptoms Common to most Infectious Diseases.

Rise of Temperature.—This is due to toxin which upsets the balance between heat-production and heat-loss. This balance is maintained by the nervous system acting on the blood-vessels, and the toxin disturbs the nervous system, so that heat-balance is lost.

To take the temperature, a clinical thermometer is used, and one must shake the mercury below 98.4°F. (normal temperature). Then place the thermometer in the mouth, with the bulb under the tongue and the lips closed, or in the arm-pit, with the arm pressed to the side of the body. This is the safer place with young children. Leave the thermometer in position for rather longer than the time marked on it, and then read it in a horizontal position. Lastly wash it in cold water or a cold disinfectant. It is well to have two thermometers, in case one gets broken.

2. Rigour, *i.e.*, attacks of shivering in which the patient feels very cold though the temperature is high. These are really spasms of contraction of the skin capillaries, owing to the disturbance of the nervous system already mentioned.

3. Rashes, due to loss of function in the skin, and the effort to excrete the waste matter accumulated in the sweat glands and other parts of the body.

4. Sore throat, headache and sickness occur in many infectious diseases.

Prevention of Infection.—For the prevention of infection, the following methods will be found useful :—

(1) **Isolation.**—The separation of the patient from the healthy. Isolation must be commenced as soon as the case is diagnosed as infectious, and must be continued until the danger from infection has ceased.

(2) **Quarantine.**—The separation of persons who have been exposed to infection. This word is used to denote the time which must elapse before a person, who has been exposed to infection, is free from that infection. Broadly speaking, it represents the incubation period of an infectious disease and consequently varies in duration.

(3) **Disinfection.**—The destruction of disease germs. Any substance which is capable of destroying disease germs is called a disinfectant or germicide.

An anti-septic is a substance which prevents the development and increase of germs, *e.g.*, iodoform, or boric acid. A disinfectant kills the germs.

The substances generally used for disinfecting purposes are as follows :—

(1) **Condy's fluid** is a popular germicide.

(2) **Carbolic acid** in a diluted condition such as 1 per cent. solution, is an anti-septic, but in 5 per cent. solutions it acts as a satisfactory disinfectant, being sometimes used to disinfect the excreta of typhoid patients.

(3) **Formalin** used in a dilution of 1 in 40 is an active disinfectant, and is stronger and cheaper than carbolic acid.

(4) **Chlorine** is one of the gaseous disinfectants. Dissolved in water, 1 per cent., it has been used for washing the walls of rooms.

(5) **Sulphur dioxide** is another gaseous disinfectant which is largely used for the disinfection of rooms.

(6) **Heat** is often resorted to—burning is the best method of disinfection. Boiling may be regarded as an efficient method of disinfection for bed and body linen.

1. Infectious Diseases.

Measles. Most of the deaths occur in children who are between two and five years of age, which shows the importance of trying to prevent little children from catching it. There are two dangerous fallacies which one often comes across :—

(1) That every child must have measles, and
(2) the younger the better.

A child need not have measles but if it does, then the older the better, for the older it is the less likely it is to die from the disease. Measles is still looked on by many people as trivial, but actually it is by no means so, and unless it is carefully nursed, often leads to complications which end in death or damage the child for life.

Incubation. 7 to 14 days, usually 12 to 14 days.

Symptoms. For the first four days a bad running cold, and this is the most infectious stage. After four days the rash appears as coarse blotchy red patches, first on the face and spreading thence all over the body. In addition there is a rise of temperature and often headache and sickness. In mild cases, the rash disappears in a few days and the child feels all right in a week, and can get up after a fortnight.

Nursing. The child should be in a warm but a well-ventilated room, and should be well wrapped up to protect it from chills.

Complications. These are very likely to develop if the case is not properly nursed, because the disease leaves the body very tender, and draughts and chills are liable to cause bronchitis and pneumonia. The signs of pneumonia are rapid heavy breathing and cough, and if these appear, the doctor should be sent for, for there is bound to be fight for the child's life. The other important complications are inflammation of eye or ear which may damage sight or hearing.

Spread of Infection is chiefly from child to child by close personal contact, especially in the early stage.

Precautions in School.

1. If cases have already occurred, send home any child

showing symptoms of a cold for four days. This will give time for the rash to appear and so settle any doubt.

2. Exclude cases for three weeks from the appearance of rash, and the period may be longer if there be complications, *e.g.*, ear-discharge.

3. Exclude all infants from an infected house and older children who have not had measles, for three weeks from the beginning of the last case in the house.

2. Whooping-Cough.

Most deaths occur in the first five years of life.

Incubation.—7 to 19 days.

Symptoms. A common cold for perhaps ten days, then fits of coughing ending in the characteristic whoop, which is due to the violent in-take of air into the lungs when nearly empty owing to the violence of the cough. The patient may go blue in the face during the fit and often vomits after it.

Infection lasts for six weeks from beginning of cough. It spreads in a similar way to measles—chiefly from child to child.

Treatment. Keep warm and free from draughts but with plenty of fresh air. The child should have good food. It need not be in bed unless the doctor orders it.

Complications. The danger is that the disease may last so long that the lungs get worn out, and lung disease such as pneumonia or tuberculosis, sets in.

Precautions in School. If cases have occurred, send home any child showing symptoms of a cold. Exclude cases for six weeks from beginning of cough. Exclude infants from infected house for six weeks from beginning of last case or three weeks from date of last exposure to infection.

3. Diphtheria.

It is always present in urban areas, and minor waves of prevalence occur frequently. The greatest number

of deaths occur before the age of ten. The disease may attack throat, wind-pipe or nose.

Incubation. 2 to 10 days, but usually 2 to 4 days.

Symptoms of Diphtheria of Throat. Sore throat, but not always violently so ; rise of temperature, but not very high. (It is worth noting that tonsillitis often causes sorer throat and higher temperature). The glands of the neck often become enlarged. The patient feels ill and a thick grey-white membrane appears on the inside of the throat. Paralysis of various parts of the body is common but passes off, but death may occur after the throat is quite well, owing to paralysis of the heart, and the patient is not safe from this danger for sometime. Hence in nursing a case great care must be taken of the heart.

Symptoms of Diphtheria of the Wind-pipe. This usually spreads from the throat, but the larynx may be the first part attacked. The symptoms are laboured breathing and usually a brassy cough. These may go on for hours only, or for days.

Symptoms of Nasal Diphtheria. This disease is often not recognised, and hence is very productive of epidemics. The throat may be quite normal, but the nose is red, sore and crusted inside and about the nostrils.

Freedom from infection is only determinable by bacteriological examination of a swab taken from the throat or nose. Relapses often occur after discharge from hospital, and considering this and also the weakness left by the disease, the child should not return to school for two or three weeks after recovery.

Spread of Infection. This is largely personal, *i.e.*, from child to child, by the breath or by sucking the same pen or pencil, drinking from the same cup, etc. Carriers play a large part in spreading diphtheria. They are people who harbour the germ in nose or throat though appearing quite well.

Young children should be immunised against diphtheria by artificial means, and this excellent method, if widely adopted, should much reduce the mortality from diphtheria.

4. Mumps.

The germs attack the salivary glands, chiefly the glands at the angles of the jaws and in front of the ears, and usually one side is attacked before the other, producing a big smooth swelling. Eating and swallowing become painful.

It is a disease of winter months and affects children, especially boys, over the age of five years.

Its incubation period is 14 to 28 days. The spread of infection is due to close contact with an infected case, especially from the breath.

Treatment. Keep warm in bed for a few days and away from others.

5. Chicken-pox.

It is a minor disease, in which the patient often does not feel it at all. Often the earliest sign is the rash, first on the body, and consisting of red spots which quickly change into pearly blisters which dry off into scabs in a few days. The scabs ultimately fall off in about 15 days.

The incubation period is 11 to 19 days, and the infection lasts for at least about 20 days. It usually spreads by direct contact with infected people.

Chicken-pox is very infectious and nearly every one suffers from it at some time. One attack normally confers permanent immunity.

6. Common Cold.

The common cold is very common in those who have enlarged tonsils and adenoids. It is an acute infection of the nasal, and throat membranes—often extending to chest. Draughts in crowded meetings are the most common cause of infection.

Once a cold is developed, the bowels should be well opened, plenty of fluid drunk, light food taken, plenty of fresh air provided, and crowds avoided.

7. Influenza.

It leads to pneumonia, may also lead to bronchitis and heart disease. Influenza is very infectious, few people are

naturally immune and an attack gives no immunity. It occurs, as we all know, in epidemics which sweep the whole country. The germ enters by way of mouth, nose or eyes, and is spread by the breath, coughing, sneezing and discharges from the nose and mouth of sufferers.

Incubation may be only a few hours, but is usually a few days.

Symptoms are usually headache, aching of back and limbs, perspiration, shivering, rise of temperature, in some cases running of eyes and nose, sneezing and cough; in other cases sickness and diarrhœa occur. When the temperature comes down, the patient is left very weak and depressed. If bronchitis or pneumonia develop, the illness is very serious.

Treatment. It is wise to treat influenza seriously, to go to bed at once, send for the doctor and stay in bed for several days after the temperature becomes normal. It pays to take as long a time as possible for convalescence, for if one gets about too soon, as most people do, one may feel the effect for months.

Duration of infection is ten days in ordinary cases, and at least three weeks in severe cases.

8. Cerebro-Spinal Fever.

Cerebro-Spinal Fever is likely to occur in conditions of overcrowding. Most cases occur in children under five, and cases over the age of forty are rare.

Incubation. Usually three to five days, but the limits are one to ten days.

Symptoms include intense headache, sickness, rise of temperature, stiff neck, etc. The mind is dulled, delirium or unconsciousness may occur. In some epidemics the rashes which give rise to the name "spotted fever," are much more pronounced than in others. Cases may be very severe or very mild, and the duration of illness varies from a few hours in very severe cases which end in death, to weeks or months but ordinary cases are ill for about two weeks. Complete recovery may take place, or various forms of paralysis may

remain, and sometimes the mind is affected. The death-rate is high.

Spread of infection is almost always by "drop-lets" shot out from mouth or nose in sneezing, coughing, talking, etc., and breathed in by another person. Most cases are infected from carriers, *i.e.*, people who harbour the germs without being ill. The disease does not spread quickly like measles or small-pox, but probably each case infects a number of carriers. Most of these only harbour the germ for two or three weeks, but some may do so for a year or more.

General precautions. The patient should be isolated, either at home or in hospital. The best preventive is an open-air life and avoidance of overcrowding by day and night.

9. Small-pox.

Small-pox is not a disease specially characteristic of children, for it attacks all ages, though amongst the unvaccinated, the death-rate is highest in children. Before vaccination was introduced, small-pox was the most fatal disease in the world, and was sometimes attended by loss of eye-sight and disfigurement of the body. The incubation period of small-pox is 10 to 14 days, but usually 12 days, and it is infectious from the very commencement to the very end of the disease.

Infection. Small-pox is intensely infectious and an unvaccinated person is extremely likely to catch it if brought in contact, say in the street or in a public conveyance, with a case of the disease or with infected clothing, bedding or furniture. The germ is given off in the breath and excretions and in the scabs from the skin, and hence not only the patient, but everything he uses, and the room he is in must be thoroughly disinfected or destroyed at the end of the illness. Infection lasts for at least six weeks, until every scab is off and the skin healed.

Symptoms in Unvaccinated Persons. Intense headache, backache, rigours and rise of temperature. On the third day, the rash usually appears, first on forehead and wrists as small red spots, which soon get hard and feel like

shots under the skin. These spread over the whole body and fill with water which turns to pus. Meanwhile the temperature goes up very high, and the patient is violently delirious. If a pock comes on the eye, it causes blindness. The pus gradually dries up and forms scales, which, when they fall off, may leave the patient marked with the typical pitting for life, and painfully disfigured. If a vaccinated person catches small-pox, as occasionally happens, the symptoms are very mild, their severity varying with the length of time since vaccination.

Vaccination was discovered by Dr. Jenner and introduced in 1798. It effects complete protection for about 7 years and partial protection for life. Undoubtedly vaccination is an invaluable weapon of defence, and that people who refuse to use it, are not only putting themselves in danger, but are failing in their duty to community.

10. Tuberculosis.

This is an important disease from many points of view. It takes a heavy toll of life, but since its recognition as infectious, it has come more and more under control. The germ (or bacillus) of the disease was discovered in 1882 by Robert Koch.

Nature of Tuberculosis. There are several varieties of germs, of which the human and bovine (*i. e.*, from the cow) are most important ; and though most cases show the human type of germ, a considerable number, especially of children, show the bovine germ. This is not surprising considering that about 40% of milking cows are tuberculous and it emphasises the need for a milk supply free from tubercle-infection. Luckily cows are not tuberculous in India.

Most of us are infected at sometime or another, but that the majority recover without ever being aware of the fact. The highest death-rate from tuberculosis is between the ages of 15 and 25, *i. e.*, in adolescence, when it accounts for nearly half the total of all deaths. The death-rate is lower in villages than in cities.

Probably the size and frequency of the doses o germs play a great part in deciding whether the individua falls a victim to the disease or not, and this explains why

it is so necessary to remove advanced cases from the family circle, or at any rate to take the greatest care about all discharges from throat, lungs, etc., if other members of the family are to escape.

Types of Tuberculosis. The germ may attack almost any part of the body, but it so often invades the lungs that the disease is usually divided into two main forms: pulmonary and non-pulmonary.

The non-pulmonary forms include tuberculosis of the lymphatic glands, of bones and joints, of the brain (meningitis), of the skin, of eyes, ears and abdominal organs. These non-pulmonary forms are only responsible for about 10% of the adult deaths.

1. Tuberculosis of bones and joints is often the cause of the acute backward spinal-curvature, sometimes called hump-back, of hip-disease, knee-disease, etc. The germ tends to attack bones at joints, causing swelling, inflammation and formation of pus, and often the end is loss of use of the joint. Many stiff legs and stiff knees are caused thus.

2. Tuberculosis of glands is specially common in the lymph glands at the sides of the neck, and chronic swelling or suppuration of these is usually tubercular.

3. Tuberculous-meningitis of the brain causes about half the deaths from tubercle below the ages of ten.

4. *Pulmonary Tuberculosis or Consumption or Phthisis.*—This form of the disease is by far the commonest in adults though not in children, and accounts for most of the cases.

Symptoms. Cough, loss of weight, lassitude, the patient looks ill and out of sorts, has a pink flush, slight rise of temperature, quickened breathing, unnaturally bright eyes and after a time expectoration with the cough.

Cause. Usually the disease arises from living in the same house with a consumptive who is careless about expectoration. The next most important cause is the inhaling of the germs in stuffy public buildings (cinemas, theatres, etc.), or in trains or streets.

Treatment has been revolutionised within the last fifty years. Now-a-days the chief, though not the only, factors

in treatment are plenty of fresh air, good food and avoidance of fatigue or overstrain.

For the sake of community, the consumptive must be very careful not to scatter expectoration, and hence (1) all spitting in public places such as streets, trains, halls, etc., should be strictly prohibited; (2) the consumptive should expectorate either into a handkerchief which is of so little value that it can be burnt and not washed, or better, into a special cup or spittoon. One who carefully observes the rules for preventing spread of infection, can live safely in the same house as a consumptive.

Sanatorium Treatment. There are now many institutions such as the one at Bhawali providing residential treatment for consumptives. The sanatorium is essentially a place in a healthy situation, where the patient can get plenty of fresh air, be under close medical supervision and keep to an exact rule of life, including enough, but not excessive food. It is meant for more or less prolonged treatment of early cases and of others in which there is a good chance of cure or arrest of the disease. Unfortunately a definite tendency to relapse remains.

Prevention of tuberculosis in children depends on the following conditions :—

(1) Removal of sources of infection by (*a*) providing milk free from the bovine tubercle germ, and (*b*) prevention of frequent or large doses of germs from a human case.

(2) A healthy environment, including good food, fresh air, cleanliness, sunlight, sufficient warmth, rest and exercise.

(3) Prevention of other diseases of childhood, especially measles and whooping-cough.

Skin diseases.

Under this head we shall deal with some of the commoner skin diseases found in schools.

1. *Scabies or Itch* (Fig. 77)is due to a germ just visible to the naked eye, one-fiftieth of an inch long, which burrows into the skin, specially in the creases between the fingers and at

the wrists, producing a track about one-eighth of an inch to one-quarter of an inch long, at the end of which she lays eggs. Hence black lines mark the burrows and little vesicles mark the tops. The irritation makes the child scratch and so produce little sores and scabs. Itching is worst at night, when the skin is warm, for then the young parasites come out of the burrows and crawl about on the skin. It is contagious, spreading over the hand and often over the whole body, and to every person in the house, and into everything in the home.

Treatment. A hot bath. Then rub all over with sulphur ointment. Put clean sheets in the bed. Next day put on clean clothes—sheets and clothes being boiled after use. All this should be repeated next night, and daily till the insect is exterminated. It usually takes one month, and often six or seven months if directions are not carefully carried out. Itch is sometimes mistaken for eczema.

(2) *Ringworm* is due to a fungus (a plant) attacking the scalp or the skin of the body, and there are two distinct types.

(*a*) Ringworm of the body may occur at any age and in any position. It begins as a spot which enlarges to the size of a rupee, and then the centre heals and the outside spreads. It can be cured in a few weeks by the use of ointment (*e.g.*, sulphur and white precipitate ointment).

(*b*) Ringworm of the scalp consists of a rough scaly patch of any size, upto one covering the whole head. The patch may be of any shape and some of the hairs on it fall out or break off short, but the hair does not fall out as a whole and hence one may not notice the patch unless one looks for it.

Spread of infection is by direct contact or by shaving brushes, hair-brushes, combs, caps, towels, etc.

The only effective treatment is by X-rays. The rays make the affected hair fall out, but the treatment is quite harmless and the hair grows again.

Malaria.

This disease is rampant throughout India, and the death-rate from it is very high. Moreover, much of the ill-health, poverty and distress in rural villages particularly, is due to malaria. It is now known that the disease is caused by a small animal parasite introduced into the blood of patients bitten by a special kind of mosquito called anopheles. It is the female mosquito that carries the parasite. Mosquitoes breed, chiefly in districts and areas where the soil is water-logged owing to the absence of proper drainage, or where there is none at all, and in streams and ditches which are obstructed in their flow. They also breed in tanks and wells and any hollow or receptacle in which water is allowed to stagnate. This explains the greater prevalence of malaria in rural districts and suburban areas than in cities and towns provided with a proper drainage system and constant water supply.

"In 1870 malaria was so bad in the Meerut Cantonment that it was nearly abandoned. A system of drainage was introduced at a cost of Rs. 1,50,000. Malaria is now practically non-existent ; 900 lives are said to be saved yearly and sickness has greatly lessened, to say nothing about the consequent economic gain. All this is due to the abolition of pools of waters" (*Lukis*).

But far greater and more successful results have been achieved throughout the world since Ross's brilliant discovery about thirty years ago, that anopheles are the source of infection. Anopheline mosquitoes are chiefly found in villages where malaria is latent or indigenous among the inhabitants, and malarial parasites may be found in large numbers in the blood of children, apparently in good health, living in such villages. Wells are often their breeding places, and the larvae of mosquitoes can be seen in water drawn from them.'

The following are some measures which have been recommended for the prevention of malaria :

(1) Houses should not be built on low-lying plots. It is well-known that malaria is most common at the foot of

hills where there is the densest jungle and the soil is swampy. It is in such sheltered and damp places that the female anopheles breed most rapidly.

(2) It is of the utmost importance that villages should be provided with proper drainage, and that all hollows in and around them for a considerable distance should be filled up. Ditches choked with weeds are a source of danger in that they form the chief breeding-places of mosquitoes.

(3) Every effort should be made, at whatever cost, to provide well-constructed and properly cemented surface drains which can be easily flushed and kept clean, and which allow water to flow through them freely.

(4) Where the use of cess-pools is unavoidable, they too, should be similarly constructed, and able to be readily cleaned out and kept clean.

(5) All discarded tin-cans, broken earthenware pots, and other receptacles in which water can collect, should be removed and disposed of at a safe distance from, and not allowed to be thrown about anywhere near houses.

(6) The hollows in trees should not be overlooked, as they form convenient places for mosquitoes to breed in.

(7) Water, moreover, should not be allowed to stand neglected too long in vessels inside dwelling houses, or in places in which animals are kept.

(8) Tanks which cannot be drained should be kept as clean as possible, and their pollution guarded against. A thin layer of kerosene oil spread over the surface of the water in them effects the destruction of mosquitoes and their larvae. Their destruction is facilitated greatly by keeping the tanks free from weeds.

When mosquitoes infest a house, their destruction may be effected by burning sulphur or naptha, which is distilled from petroleum ; or any of the derivatives of naptha may be used. Formalin, which is one of them, is often used for disinfecting purposes, and is a good insecticide.

Individuals may secure protection from the bites of infected mosquitoes by sleeping inside mosquito nets. Especially is this desirable in the night time when mosquitoes are most active.

Protection may also be afforded by the isolation persons suffering from an attack of malarial fever.

Finally, the more extensive use of quinine in malarious districts is strongly advised as the best means of preventing malarial attacks so far as medicinal treatment is concerned. This medicine can be bought at any Post-Office in India. An adult may take as much as 4 or 5 grains every four hours, or even larger doses at longer intervals, and young children 1 or 2 grains three times daily. There can be no doubt that of all remedies for malarial fever quinine has been proved to be the most valuable.

Rheumatism. It includes rheumatic fever, muscular rheumatism (*i.e.*, stiff-neck, *etc.*), lumbago, sciatica and other forms of neuritis, as well as various chronic affections such as gout and arthritis. It is with rheumatic fever that we are here concerned.

Rheumatic fever is thought to be due, not to a specific germ, but to a group of germs which are specific for septic conditions, such as tonsillitis and abscesses arising from decayed teeth. There are no apparent symptoms and signs. Damp alone does not cause acute rheumatism, for, during the World-War, the incidence of acute rheumatism among the troops was lower than it was among the civil population, in spite of the fact that soldiers had frequently to serve in water-logged trenches. One of the main causes seems to be faulty surroundings and the disease is more prevalent among the poorer middle class than the utterly destitute. A typical case of rheumatic fever shows high fever, sweating, and joints red and swollen ; but as a rule this occurs only in older children. One of the most dangerous complications of rheumatism is its propensity to heart diseases. Unfortunately, the younger the child the greater the liability to heart trouble, and the physical signs are less evident in the young. Consequently, in the so-called "growing pains", which are really rheumatic in character, damage to the heart is quite likely to ensue.

CHAPTER XXII

SCHOOL HYGIENE

Children in many schools work under very unhealthy conditions. In most cases the surroundings are such as to counteract effectively any instructions in hygiene that may be imparted.

Definite progress has, in consequence, to be made in regarding the various unsatisfactory conditions, and the Board of Education has consistently encouraged local educational authorities to exercise their powers in improving conditions in the schools.

It is essential that the teachers, school managers and members of school committees should have a good knowledge of what is necessary in the way of structure and equipment in order that a school may be a healthy place for growing boys and girls.

If such knowledge were universal and properly applied, our schools would cease to be regarded as places where colds and other infectious diseases are contracted.

The school should educate the child in every sense of the word, and that children who may be able to recite historical dates, geographical facts, and to do all kinds of tricks with figures, are yet grossly ignorant if they do not know the essential facts concerning food, clothing, ventilation, and the general principles of healthy living. There is no doubt about it that more or less total ignorance concerning such essentials is the cause of much unhappiness and disease that exist at the present time.

Whatever their environment may be, it is extremely rare to find people making the best of things from a hygienic stand-point. Only persistent education can make people recognise that individual attention and care are essential, if the maximum amount of health is to be obtained.

Every experienced public health worker knows that most people do live in just as filthy and unhealthy conditions in modern houses as they do in 'slum *bastis.*'

Ventilation is still an unknown idea among most people.

If these things are to be improved, it is obviously desirable that the education given in our schools should include sound instructions in the essentials of healthy living.

Moreover, if such education is to make any permanent impression upon the children, their surroundings at school should be scrupulously clean, attractive and healthy.

In 1913, a Committee appointed by the U. P. Government submitted a very exhaustive report on Education Hygiene with special reference to the educational institutions throughout the Provinces.

Regarding the teaching of hygiene, the Committee remarked :—

" The provision of hygienic surroundings in schools is of the highest importance in the teaching of the elements of hygiene. It is of little use to teach dogmatically the advantages of clean and wholesome surroundings where such are not provided. The impressions of childhood are deep and lasting, and it is necessary therefore that they should be in all respects sound. Neatness, tidiness, cleanliness, freshness of atmosphere, punctuality and orderliness in school, leave impressions on scholars which are likely to have lasting effects in their after-life. The hygienic conditions of the school should, therefore, in all cases, be of a vastly higher standard than those to which the scholar is accustomed in his own home. Teachers also must show to their pupils that they practice what they preach, and that they themselves are tidy and clean in their person and clothing, punctual and orderly in their work, and of good moral character. They should, in their own lives, carry out the precepts of hygiene which they themselves have been taught."

The Committee recommended the periodical examination of sanitary conditions of all educational institutions and suggested the appointment of Health Officers for the health

inspection of children with special reference to eye diseases, infectious diseases, malaria and tuberculosis.

The important causes which affect the health of students injuriously are as follows :—

(*a*) Unhealthy surroundings.

(*b*) Irregular work throughout the session.

(*c*) Serious overwork just before the annual examinations.

(*d*) Too much home-work.

The School. The site of a school should be selected with great care. It should be at least sixty feet from the road. It should be an open and sunny site, if possible, within easy reach of a public park or recreation ground, in which games can be played.

The playground should be levelled and enclosed. Since the function of a playground is to provide space for play and team-games, the area should be adequate.

The School Building. The usual plan is that of a central hall, round which the rooms are ranged. In this plan adequate natural ventilation is extremely difficult.

The latest arrangement of the building is of the pavilion type whereby the class rooms open into verandahs and the hall is quite separate.

Class-rooms. The class-rooms should be rectangular with the greater sides about one-fifth longer than the shorter sides. Each pupil should have a floor area of 20 square feet. Floors, walls and roofs should always be kept clean.

Desks. The size and type of desks are of great importance for the prevention of eye-strain and fatigue. The best type is a single desk and stool, but combination desks may be used.

Ventilation. Most schools can be satisfactorily ventilated by windows. Ventilation by windows is satisfactory except in the case of dusty and noisy areas. Proper ventilation diminishes infection, lessens fatigue and eye-strain.

Lighting. The class room should be fully lighted. The light should, as far as possible, come from the left hand, so that in writing the shadow of the hand will not come in the way. The windows should be so placed as to light every part of the room, more or less entirely and sufficiently. The class-room should have the windows so placed that, if possible, some part of the sky may be seen from any part of the room.

Sanitary Arrangements. The latrines and urinals should be placed away from the school building and must always be kept scrupulously clean.

Drinking Water. There should be a separate room for the storage of drinking water. The *gharrâs* must be placed on a raised cement platform and must, on no account, be kept on the ground. The provision of abundant and pure drinking water is a necessity for all children. The use of common metal cups for drinking purposes is dangerous and should not be permitted.

Black-boards. The slate black-board is the best for it can be washed clean. The slate should have a dull surface which does not reflect light. The inhalation of chalk dust is injurious to health, and for this reason, it is advisable always to use a slightly damp duster.

General Cleanliness. Articles of furniture, doors and windows, walls, roofs and floor should always be kept perfectly clean. It must be remembered that dust is the most potent cause of ill-health, and every effort should be made to prevent a dusty atmosphere in schools.

The School Medical Examination. All school children must be periodically examined by a qualified doctor. Each pupil should have his own medical card which must be kept in the school. The school medical examinations tend to foster self-respect in the parents, and that the influence of a clean and healthy school, which promotes the welfare of its pupils, soon brings about a corresponding attitude on the part of parents.

CHAPTER XXIII

THE HEALTH OF THE COMMUNITY

In all civilised countries we find that to a lesser or greater degree rules are made to improve the health of the community and individuals are expected to obey these rules since healthy units make a healthy whole.

Before the enormous strides made during the nineteenth century in our knowledge of science and medicine, many of the rules had been laid down, because it had been found by experience that in the absence of such rules ill-health occurred or diseases spread. Fortunately we live in a time when the workings of the body and the causes of ill-health are so much more accurately known, that the reasons for the laws that are made and for the plans adopted to secure communal good health and happiness are generally understood *and accepted, and most of us try to co-operate in making* them effective. Perhaps the most striking thing about the present-day Public Health Measures is the fact that they aim primarily at the prevention of ill-health.

It will be a long time, if ever, before disease is stamped out, but the battle against it can be fought by striving to possess good health. Measures which prevent disease (preventive medicine) are as important as those which treat disease (curative medicine.)

One of the very noticeable differences between the middle ages and the present day, is the absence of the terrible epidemics that in those days used to carry off great numbers of people. In 1349, the Black Death in England wiped out about half the population and the four millions were reduced to two. Small-pox and typhus alone caused the death of hundreds yearly. In India now, there are not so many cases of small-pox as there used to be in pre-vaccination days, and these usually among the unvaccinated.

Such improvements can only occur if we take advantage of the information provided for us by scientific research.

We now know that the so-called infectious diseases are spread from person to person, sometimes by direct contact with a diseased person or by contact with clothes and utensils touched by such a person ; sometimes by lice and flies and dirty food ; and sometimes by infected water or milk. Once having learnt the way in which infection is spread, the problem of the prevention of a disease and of epidemics is a matter of education, and is in our own hands.

The prevention and cure of disease has been greatly helped by our knowledge of the forces used by the body in its fight against germs. In many cases the white corpuscles attack and engulf the germs, but the body possesses another method of combating an infection. It can develop substances (anti-toxins) which will 'neutralise' the poisons (toxins) set free by the germs. Sometimes whole groups of people or kinds of animals are naturally immune to a disease. Negroes seem to be immune to yellow fever and sheep are immune to tuberculosis.

In 1789, when small-pox was still a devastating plague in England, Dr. Jenner observed that cowherds and milkmaids did not share with other people the liability to small-pox. He discovered that on the udders of cows there were often spots not unlike those of patients suffering from small-pox, and that the hands of the milkers also often showed similar spots. He thought that perhaps this meant that the cows were suffering from a kind of small-pox and that they infected the milkers, who also had a sort of local attack. It was known that people who had had one attack of small-pox and had recovered, practically never had another attack and it was suggested to Dr. Jenner that the slight attack of cow-pox given to the milkers protected them against the more virulent variety then so prevalent.

Acting upon this idea, he proceeded to give this mild local 'pox' to his own child, by rubbing into a scratch on the skin some of the fluid from a spot on a cow's udder. He found that after the mild attack, the child could withstand inoculation with fluid from a pustule from a case of the virulent type of small-pox. After continued experimenting it seemed quite evident that his theory was a true explanation of what occurred, and that an attack of 'cow-pox' was as good a method—and a far safer one—of acquiring immunity

from the human virulent variety, as well as previous attack of the disease. This way of deliberately obtaining immunity from small-pox constitutes vaccination and has been in use ever since.

Vaccination in most cases only produces a local infection with no general ill-effects ; but occasionally there are individuals in whom the response to vaccination is severe, though even in these cases serious consequences are unlikely to occur. Nevertheless most thinking people believe it right that we should all be vaccinated, so that the whole community may become immune and small-pox will be stamped out. Serious consequences from vaccination are much less likely to happen in infancy; and it is, therefore, best to have a child vaccinated before it is a year old.

There also seems no doubt that vaccination, even if it does not always give continued immunity from small-pox, does greatly reduce the severity of an attack should a vaccinated person become infected.

The prevention of disease is a matter of common concern and since the value of vaccination as a means of preventing small-pox is generally accepted by the community, free vaccination is part of the Public Health Services.

The immunity obtained by vaccination is presumably brought about by the large excess of anti-toxin developed during the local attack produced by the cow-pox virus. Several other diseases are treated in a similar way and inoculation is now a recognised weapon in preventive medicine. The longest immunity is obtained by giving the person a mild attack of the particular disease, but a temporary immunity can also be acquired by inoculating with the anti-toxin itself. This form is the immunity obtained for diphtheria and, as it is the anti-toxin that is introduced, this injection can be used in the early stage of an attack of the disease itself to give the patient a strengthened line of resistance until his or her own anti-bodies have been formed.

The effects of a definite attack of an infectious disease are more serious during the period of growth and efforts should be made to protect children from infection, by deliberate immunisation, where possible, or by avoidance of

direct contact with disease. X-ray photographs of bones show that the development may be arrested by an attack of an infectious disease ; and a severe attack of one of the common infectious diseases may leave a weakened heart or greatly reduce the power of the individual to resist infection from other diseases. It must be remembered that the ill-effects that persist after an attack of a disease may heavily handicap the individual for the rest of the life, so that living loses much of its joy and not only may that individual be of little use to the community but he or she may be a continued public responsibility and expense ; and the health of that person's children be influenced adversely.

To prevent the spread of disease, every case of the so-called Notifiable Infectious Diseases must be notified to the Public Health Authorities, who can then arrange, if necessary, for the removal of the patient to an isolation hospital ; for the disinfection of the room or house ; and for the observation of people who may have been infected before the isolation of the patient.

Health can and should be our possession if we live in healthy surroundings. During the nineteenth century, the growth of industry was so rapid that adverse conditions developed and were established before their danger to the community had been realised ; so that one of our battles in preventive medicine is that of getting rid of conditions that are bad and of substituting better ones. A case in point is found in all our big cities, where there is overcrowding in buildings that are often airless, sunless and damp. It is true that such conditions are harmful to all, but they are terribly bad for the children ; and, since the health of the children determines the health of the next generation of grown-ups, everyone who cares about Public Health, looks upon the Housing Problem as of vital importance for the future of the country. As slum-areas are demolished, new houses must be built, and it is the business of the community through its Local Municipal Board to see that these new buildings are not going to suffer from the defects of the old ones and that they will really be airy, sunny, warm and dry ; and near open spaces and trees.

Public Health measures may be considered from two points of view : (*i*) what the community does to keep its

good health and improve the general standard of healthiness ; (*ii*) what the community does to cure disease and prevent its spread.

It is the duty of the Public Health Department to regulate the conditions likely to affect the health of the community. Such laws are concerned with the way in which houses are built, with the problem of house and street drainage and with the disposal of sewage ; with the collection and destruction of domestic and street refuse, with the supplying of a sufficiency of pure water for drinking purposes and for cleaning purposes; with the way in which food is sold and the quality of these foods ; with the cleanliness and health of cows and milkers and the sale of clean milk ; with the notification to the proper authorities cases of infectious disease and the isolation and care of the sick people ; with the health of the industrial worker and with the health of mothers, babies and school children.

Most of the Public Health Services are free to the community and are paid for through the money collected by Municipal and District Boards in taxes.

Some of the most useful health measures are those concerned with the health of mothers, babies, children and workers.

At an Ante-Natal Clinic an expectant mother can get advice before her baby is born ; and from the time of its birth until it reaches school-age, both her own health and that of her baby is the concern of the Health Visitor and the Doctor of the Maternity and Child Welfare Centre she attends. Day-Nurseries, Creches and Nursery Schools provide safety and care for babies and young children of mothers who are obliged to work outside the home. During school years, there are periodic medical inspections ; and children not in normal health, and those who are crippled, deaf, or blind are sent to special schools. Because we now realise how tremendously important to health is feeding. Public Health Services look after mothers and young children in cases of real need. The help is given as additional food, either as free milk or milk at a reduced price for the mothers, or in the form of free dinners and free milk at school for children.

The health of the workers is also looked after by the community and there are regulations for the proper ventilation, lighting and cleanliness of factories and work-places, and for reducing risks to health in certain unhealthy trades.

Tuberculosis is still prevalent and must be considered a serious disease ; but there are now few cases of 'galloping consumption' and few instances of all members of a family dying of this disease within a short period. The improved health of the community has raised the average age at least by fifteen years. A new outlook in matters of health has been developed and the community realises the need for personal, domestic and public cleanliness and is less tolerant of bad hygienic conditions and of a slack Public Health authority. But a higher standard of healthful living is still required and only by persistent wise education can public opinion be trained to demand improvements.

Modern Movements for the Education of Community in the Laws of Health.

The most important of these movements is the maternal and infant welfare work, the object of which is to try to reduce the high death-rate among mothers and infants at child birth, or ailments occurring afterwards.

The high maternal mortality in India is acknowledged to be due, chiefly, to early marriage, which the late Dr. Mohendra Lal Sircar regarded as the greatest evil in India. At a public meeting he said : "From medical observation extending over thirty years, he could say that 25 per cent. of Hindu women died prematurely through early marriage, 25 per cent. more were invalided by the same cause, and the vast majority of the remainder suffered in health from it."

More recently in an address delivered at a Social Congress at Bombay, His Highness the Gaekwar of Baroda remarked : " It is not necessary for me to dwell upon all those familiar questions which cluster round the question of the status of women. I would merely point out that

early marriage must increase death and disease among the mothers, swell infant mortality, and injure the physique of the race. It interferes also with the proper education of women."

Besides early marriage, physical malformations and diseases, which may develop in expectant mothers, are, to a considerable extent, responsible for both maternal and infant deaths, either during child birth, or, in the case of infants, in the early years of life, owing to their enfeebled condition when born.

Maternal and Child Welfare Centres. These are institutions which have been established, within recent years, for the purpose of giving medical aid to certain classes of women and children whose circumstances are such that they may be unable to get the required aid otherwise.

Maternal and Child Welfare in India. The first step taken was when Lady Willingdon opened Maternity Homes at Bombay, and organised a system of house-to-house visiting.

In 1914, two health visitors, with special qualifications, were appointed to organise the work in Delhi as a first-class centre, as a model for similar work in other parts of India. This proved a great success. In 1918, in order to provide trained workers, a training school, under the superintendence of the health visitors, was started at Delhi, and since then trained workers have been appointed to posts in different parts of India. The late Sir Pardey Lukis, then Director-General of the Indian Medical Service, was mainly instrumental in the institution of this scheme.

In 1926, the Lady Reading Health School was opened as a permanent training school, and about the same time the Ramchandra Lohia Infant Welfare Centre for the welfare of mothers and babies in Delhi and the training of students was founded.

In 1920, a Maternity and Child Welfare Exhibition was organised at Delhi. Dr. Balfour, with regard to this exhibition, says: "Pains were taken to insure that this should be of an All-India character, and delegates were invited from all parts of the country; a conference of

doctors, health visitors and nurses was held—the first of its kind in India; and there is no doubt the principle of prevention laid down there soon began to be better understood by workers throughout India."

In the same year Lady Chelmsford, through funds collected by her, announced the formation of the All-India League for Maternity and Child Welfare. Branches of the League were formed in the different provinces, and Dr. Balfour says: "from that time onwards Centres began to multiply".

In 1924, the late Lady Reading inaugurated the National Baby Week, regarding which Dr. Balfour says: "None of the schemes for Child Welfare has proved so popular as this," and considers the rapidly-growing interest in Child Welfare and the growth of new Centres as a direct consequence.

Even before the inauguration of Baby Week, Dr. Balfour states that the Red Cross had turned to Child Welfare as a suitable field for its peace-time activities, and had decided to devote some of its large funds to that purpose, and adds "the Lady Chelmsford League and Red Cross jointly organised the first Baby Week."

Dr. Balfour gives the following figures, showing the infant mortality in Madras, Calcutta and Bombay during the year 1926:—

Madras ...	... 279 per 1,000 live births.
Calcutta ..	... 317 " " " "
Bombay ...	.. 419 " " " "

And in referring to the high maternal and infant mortality in India, she directs attention to the fact that, except in the United Provinces, where a medical woman had been appointed by Government to supervise and organise it, maternal and child welfare work comes nominally under the Public Health Department. It may be concluded, however, from what follows, that the Public Health Departments in India are fully alive to their responsibility in the matter, although no doubt a special department to deal with maternal and child welfare work might achieve more satisfactory results.

In his report for 1928, Major C. M. Ganapathy, I.M.S., Director of Public Health for the Central Provinces and Berar, states that the infant death-rate in that area was over 238 per 1,000, and again higher than any other province, and adds that nearly one-third of the total mortality of the area was due to the deaths of infants under one year of age. It may be concluded, therefore, that the infant death-rate in Madras, Calcutta and Bombay has considerably decreased since 1925. Lt. Col. Ganapathy states in his report that, during the year 1928, fourteen new Infant Welfare Centres were established, bringing the total of these institutions to thirty-five at the end of the year, and that the establishment of additional centres is contemplated.

GLOSSARY.

Adrenals.—The ductless glands which are located above the kidneys.

Adrenalin.—The secretion of the medulla of the adrenal glands.

Afferent.—From periphery towards the centre.

Artery.—A blood-vessel carrying blood from the heart.

Auricle.—A chamber of the heart.

Bacteirium.—A germ, plural, bacteria.

Blood.—The bodily tissue which goes to all other tissues.

Brain.—The chief organ of the central nervous system.

Cœcum.—The beginning portion of the large intestine.

Calorie.—The unit of measure of heat, or heat energy.

Capillary.—The smallest division of the blood-vessels.

Carbohydrate.—Starch.

Cell.—The structural unit of living matter.

Cerebellum.—A part of the central nervous system located below the brain.

Cerebrum.—A part of the central nervous system strictly, the brain.

Cochlea.—The end organ of hearing.

Colon.—The large intestine.

Combustion.—The process of burning.

Connective Tissue.—Any collection of cells of the nature of connective cells.

Co-ordination.—Smooth working.

Cord, Spinal.—The lowest part of the central nervous system.

Chyme.—The pulpy mass of undigested food in the intestines.

Cretinism.—Subnormal, physical and mental growth owing to the deficiency of the Thyroid gland.

Efferent.—From centre towards the periphery.

Emulsion.—Mixture of fats and water.

Endolymph.—Fluid in the labyrinth of the internal ear.

Energy.—The power by which anything acts effectively to move or change other things or accomplish any result.

Epiglottis.—Cartilaginous flap which closes over the larynx on swallowing.

Epiphysis.—See Pineal.

Epithelium.—A tissue made up of epithelial cells; they are usually on the surface areas, such as the skin, the lining of the mouth, windpipe, stomach, intestines and bladder.

Expiration.—The period during which air is expelled from the lungs.

Fats.—They are compounds of glycerine and fatty acids. They supply heat and energy.

Fœtus.—The embryo in the womb.

Fibre, Nerve.—The extension from a nerve-cell. It makes connections with other nerve-cells, with muscles, or with sensory end organs.

Functional.—In use by physicians to designate an ailment which has no anatomic basis. The opposite of organic.

Glucose.—A simple form of sugar.

Glycogen.—A starch produced in animal livers. It is formed from glucose. When energy is needed by the muscles, glycogen is converted into glucose and sent to the muscles and burned.

Hormone.—A chemical substance, usually elaborated by a gland of internal secretion, which, after absorption into the blood co-ordinates certain vegetative bodily functions. Examples are epinephrin, the secretion of adrenal glands, insulin, the internal secretion of the pancreas and thyroxin, from the thyroid.

Hypophysis.—See Pituitary.

Inflammation.—The succession of changes in living tissue, due to injury.

Inspiration.—The period during which air enters the lungs.

Labyrinth.—Part of the inner ear.

Larynx.—The upper part of the windpipe.

Langerhans, Islets of.—The ductless glands embedded in the pancreas.

Leucocyte.—One of the white cells of the blood.

Lymph.—A colourless alkaline nutritive fluid in animal bodies probably derived from blood-serum.

Malignant.—Referring to a pathologic process, of a grave nature, tending towards a fatal outcome.

Medulla Oblongata.—A part of the central nervous system. It contains large ganglia, such as the origin of cranial nerves, and it also contains many fibres from the cord going to the brain and *vice versa.*

Metabolism.—Nutrition.

Nitrogenous.—Containing nitrogen.

Organic.—In use by physicians to designate an ailment which has an anatomical change as a basis. The opposite of functional.

Ovary.—The female germ organ.

Ovum.—An egg cell.

Pepsin.—The digestive enzyme of the stomach (digests only proteins.)

Pineal.—A ductless gland, located in the skull cavity.

Pituitary.—A ductless gland, located at the base of the brain.

Plasma.—The fluid part of blood in which the corpuscles float.

Proteins.—Substances composed of carbon, hydrogen, nitrogen, oxygen, sulphur and mineral matter. The two main forms are albumin and globulin.

Protoplasm.—Colloidal egg-white substance which forms the interior of all cells. Composed of oxygen, nitrogen, carbon, hydrogen and traces of sulphur.

Prostate.—A large gland at the base of the male bladder.

Ptyalin.—The digestive enzyme of the salivary glands.

Pylorus.—The outlet of the stomach into the intestines.

Serum.—The part of the blood which is squeezed out of the clot. The liquid part of the blood.

Spinal cord.—See cord, spinal.

Spleen.—An organ belonging to the blood system.

Starch.—A carbohydrate.

Sugar.—A carbohydrate.

Thyroid.—A ductless gland in the neck.

Tissue.—Any collection of living cells in one organism.

Toxin.—Poison.

Tubes, Eustachian.—The connection between the throat and the middle ear.

Tube, Fallopian.—The portion of the female organs of reproduction which serve to conduct the ova from the ovary to the uterus.

Uterus.—The womb.

Vagina.—A portion of the female genital tract.

Vein.—A blood-vessel, carrying blood towards the heart.

Ventricle.—A chamber of the heart.

Viscera.—Organs of the body, as the heart, lungs, stomach, liver, intestines, brain, kidneys, etc.

Vitamins.—Chemical constituents of foodstuffs which have great influence on nutrition.

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